DEPARTMENT OF EDUCATION

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Curriculum Branch

Interim

GENERAL SCIENCE PROGRAM

for the

Junior High School Grades

for

1949 - 1950

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This Bulletin has been prepared by the Subcommittee on Junior High School Science under the guidance and direction of the Junior High School Curriculum Committee.

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FOREWORD

This outline of Junior High School Science is an interim program for the year 1949-50 only. Sufficient copies have been printed to permit distribution to all interested persons and to a number of classrooms that will be teaching these new courses on an experimental basis during the school year 1949-50. During the one-year trial revisions will be made and the new program in science published so that full distribution can be made throughout the Province for the school year 1950-51. This new program will be offered on an experimental basis in a limited number of schools, with the expectation that it will be a part of the junior high school program in all schools in 1950-51.

Since this new program differs from the old one in content and approach, we hope that teachers will study it carefully and critically in order that a thorough evaluation can be made before such a program is finally adopted. The first part, setting forth the Guiding Principles, should help to clarify the new point of view.

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PART ONE

GUIDING PRINCIPLES

Place and Importance of General Science Education

We live in an age when science greatly influences the lives of men. Modern youth must be cognizant of the impact of science on their lives and learn to understand how man lives and spends his leisure time in a scientific world. We live in a world of rapid change and discovery, where knowledge is limitless and the search for truth goes on indefinitely. Most junior high school students have reached adolescent age with its attendant interests and needs. For them, the newspaper, the radio and the newsreel are replete with scientific items. Boys and girls work and play together in a scientific environment of cars, buses, tractors, trucks, trains, wurlitzers, telephones and combination radios. They are trained to organize extracurricular activities, to broadcast their school choir over the air or over a public address system, to handle the lighting effects for a stage performance, to repair household equipment and appliances, to decorate the home during the Christmas holiday season, to interpret camera exposure tables for their flash attachment--such is the science environment of modern youth. It is apparent, therefore, that science holds a rightful place in the school curriculum. Junior high school science is an intermediate stage between the general science activities of the elementary grades and the advanced science work of the senior high school. The total general science program represents the common knowledge which all students should possess whether or not their high school general science is terminal or a preparation for university science.

General Science is a Part of the General Education Program of the Junior High School.

The subject of general science is particularly well suited to the "broad-fields" type of curriculum organization which is receiving greater emphasis in Alberta and upon which this program is based Under this scheme of organization large areas of learning such as general science, mathematics, language, and social studies, along with certain electives comprise the total curriculum.

Junior High School Science is Environmental Science and Preparatory Science.

The junior high school science program is a continuation of the study of the child's environment encountered in the elementary grades. Junior high school science serves as a two-fold preparation for either the general science or the special sciences of the senior high school grades. The special sciences for which general science serves as adequate preparation are biology, chemistry, geology, and physics.

The content of the junior high school science program is such that it can conveniently be taken by students who have studied the science enterprises and the parallel activities of science in the elementary grades. The general science problem-studies will permit a student to pursue either the general science studies or the special science studies of the senior high school.

Functional Science

An expression that has become common in curriculum studies in recent years is the word "functional". The general science program must "function" or carry over into the lives of the students, both now and later when they take their place in society in their post-school years. Students in junior and in senior high school will receive training in the scientific method of problem-solving and their science experiences must be selected in terms of use or function.

The Status of Health Education

Health education is an integral part of the general science curriculum. The various health units with their related sub-problems include studies which should lead to understandings in the following areas:

1. Body structure
2. Body nutrition
3. Communicable diseases
4. Safety education
5. Alcohol and narcotics
6. First aid
7. Individual and community health problems

Introductory Guide to Basic Principles

It may be helpful at this point to indicate the general pattern or guiding principles underlying this new program in order that the reader may appreciate the approach which has been taken and get a preview of the remaining contents of this publication.

Following are some of the features which may be considered as the guiding principles or the salient features of this new program:

1. The entire program has a general science pattern, which is well articulated with the general science of the elementary school and could serve as an adequate foundation for general science courses that may be set up for the senior high school.

2. The course content and suggested procedures for instruction relate specifically to a complete and carefully stated list of objectives.

3. The program is organized on a scope and sequence pattern. That is to say, a number of areas chosen for study are the same for each grade and expanded through the three grades in sequence.

4. With respect to methodology, the unit study method is recommended. The objectives of the course can be more easily and fully realized by the use of this method.

5. The emphasis is upon direct experience of the student, and the planning, organizing, and carrying out of science activities is democratic.

6. A program of evaluation based upon desirable changes in pupil behavior is advocated.

PART TWO

OBJECTIVES

If science education is to do its part in attaining worthwhile purposes in education the entire program must be based on well-founded objectives. In Alberta we believe that the functional objectives of secondary education should be:

1. Personal Development
2. Growth in Family Living
3. Growth Toward Competence in Citizenship
4. Occupational Preparation

These objectives may be achieved through general science education as indicated below.

1. Personal Development

(1) Arousing a curiosity about things around us.
(2) Developing ability to speak intelligently about our scientific progress.
(3) Developing ability to compute with scientific measures.
(4) Listening intelligently to addresses on scientific subjects.
(5) Reading scientific articles and publications in magazines and periodicals.
(6) Understanding those health and disease factors which contribute to our personal health and comfort and that of others.
(7) Taking advantage of scientifically improved forms of recreation.
(8) Using leisure time wisely in a scientific world.
(9) Appreciating the painstaking and high quality work of the scientist.
(10) Exercising shrewd judgment in expenditures as a consumer.
(11) Exercising shrewd judgment in expenditures as a purchaser and knowing sufficient science to protect our interests.

2. Growth in Family Living

(1) Strengthening family life and making our homes more comfortable through the use of labor-saving devices.
(2) Training prospective parents in the art of home-making which today calls for understanding of scientific equipment and conveniences.
(3) Maintaining a democratic atmosphere in home and school by permitting all members to express opinions regarding problem situations of family and group life with proper respect for parents and elders.

3. Growth Toward Competence in Citizenship

(1) Desiring to bring social justice to all by providing scientific conveniences to all our people.
(2) Desiring to improve the unsatisfactory living conditions in our communities and in the nation.

(3) Searching for truth rather than surrendering to unscientific propaganda not based on fact.
(4) Developing a tolerant attitude toward the opinion of others based on willingness to weigh and assess facts.
(5) Appreciating the need for the scientific conservation of our natural resources.
(6) Measuring scientific advance in terms of the common good.
(7) Cooperating as a member of our scientific world community.
(8) Making decisions as a political citizen on legislation affected by science and technology.

4. Occupational Preparation

(1) Understanding the scientific knowledge and comprehension required in various types of jobs.
(2) Guiding the child toward an intelligent selection of an occupation, which may possibly require scientific knowledge.
(3) Discovering and developing aptitudes for wise selection of life work.
(4) Improving efficiency by further study, which may involve an extension of scientific knowledge and understanding.
(5) Developing a scientific attitude to problems encountered.

TYPES OF OBJECTIVES FOR SCIENCE TEACHING

When the preparation of programs of study is undertaken the general functional objectives should be analyzed and subdivided into more specific and simplified lists to include understandings, skills, interests, etc. A statement of objectives, like the objectives themselves, is intended in a real sense to indicate directions of growth--perhaps never complete but always in need of some revision. The following is a list of the common types of objectives for science teaching taken from the Forty-Sixth Yearbook of the National Society for the Study of Education, Part I, SCIENCE EDUCATION IN AMERICAN SCHOOLS, which agree with the principles upon which the Alberta program is based.

A. Functional information or facts about such matters as:

1. Our universe -- earth, sun, moon, stars, weather, and climate.
2. Living things -- plants and animals.
3. The human body -- structure, functions, and care.
4. The nature of matter - elements, compounds, mixtures, chemical change, physical change, solids, liquids, gases.
5. Energy -- sources, types of energy, machines.
6. Contributions of science to the life of our time -- radio, telephone, telegraph, electric lights, motion picture, household appliances, and airplanes.

B. Functional concepts, such as:

1. Space is vast.
2. The earth is very old.
3. All life has evolved from simpler forms.
4. All matter is probably electrical in structure.

C. Functional understanding of principles, such as:

1. All living things reproduce their kind.
2. Changes in the seasons and differences in weather and climate depend largely upon the relation of the earth to the sun.
3. Energy can be changed from one form to another.
4. All matter is composed of single elements or combinations of elements.
5. Living things in a given environment or locality are mutually interdependent.

D. Instrumental skills, such as ability to:

1. Read science content with understanding and satisfaction.
2. Perform fundamental operations with reasonable accuracy.
3. Perform simple manipulatory activities with science equipment.
4. Read maps, graphs, charts, and tables and to interpret them.
5. Make accurate measurements, readings, titrations, etc.

E. Problem-solving skills, such as ability to:

1. Sense a problem.
2. Define the problem.
3. Study the situation for all facts and clues bearing upon the problem.
4. Make the best tentative explanations or hypotheses.
5. Select the most likely hypothesis.
6. Test the hypothesis by experimental or other means.
7. Accept tentatively, or reject the hypothesis and test other hypotheses.
8. Draw conclusions.

F. Attitudes, such as:

1. Open-mindedness--willingness to consider new facts.
2. Intellectual honesty -- scientific integrity, unwillingness to compromise with truth as known.
3. Suspended judgment -- scientific control, withholding conclusions until all available facts are in, not generalizing from insufficient data.

G. Appreciations, such as:

1. Appreciation of the contributions of scientists.
2. Appreciation of basic cause-and-effect relationships.
3. Sensitivity to possible uses and applications of science in personal relationships and disposition to use scientific knowledge and abilities in such relationships (attitude).

H. Interests, such as:

1. Interest in some phase of science as a recreational activity or hobby.
2. Interest in science as a field for a vocation.

To make this list more meaningful and useful, each type of objective is listed again together with a statement of an anticipated objective, an example, and a possible use.

Category 1: Functional Facts and Information

Statement of anticipated objective: To train the student to utilize scientific facts and information so as to make him now, and later as a citizen, better able to use such facts in actual or relevant situations.

Example of a fact: Time differs in different part of the earth.

Use of the fact: In travelling across Canada, there are times when we are instructed to change our watches by one hour.

Category 2: Functional Concepts

Statement of anticipated objective: To develop in the student the ability to use scientific ideas or concepts as an unfamilar situation arises in which the concept plays a part.

Example of a concept: Man is a factor in environmental change.

Use of the concept: Much soil in southern Alberta has been made productive by man's ability to control water by irrigation.

Category 3: Functional Understanding of Principles

Statement of anticipated objective: To develop understandings in youth by using an idea or concept in many different situations of increasing scope and difficulty.

Example of a functional understanding of principle: Energy can be changed from one form to another.

Use of the functional understanding: The use of magnets in electric motors to change electrical energy to mechanical energy.

Category 4: Instrumental Skills

Statement of anticipated objective: To teach the student to perform essential skills in the field of science such as reading, measurement, computation, manipulation of equipment, interpreting maps, graphs and charts.

Example of an instrumental skill: Interpretation of meteorological data and weather maps.

Use of the skill: Intelligent reference to weather data and radio reports prior to starting on a long pleasure trip by car.

Category 5: Problem-solving Skills

Statement of anticipated objective: To develop in the student problem-solving ability in order to grow in clear and independent thinking.

Example of a problem-solving skill: Facing the problem of making a home rumpus-room or of wiring a garage.

Use of a problem-solving skill: Sensing the problem; defining it; gathering facts and clues; making tentative guesses and suggestions; selecting the best suggestions; testing the suggestions; tentatively accepting certain suggestions; reaching conclusions; applying the learning to new situations later.

Category 6: Attitudes

Statement of anticipated objective: To train the student to avoid snap judgments or generalizations based on insufficient data.

Example of an attitude: Maintaining an open mind or suspending judgment because of insufficient information.

Use of this learned attitude: Tolerant toward people with views of life different from ours.

Category 7: Appreciations

Statement of anticipated objective: To permit students to develop an appreciation for the contribution of scientists and a readiness to use scientific knowledge in personal problems.

Example of an appreciation: Appreciation of the progress that man has made in the preservation of human life, especially in the areas of community and individual health.

Use of this appreciation: Becoming a blood donor at a Red Cross Clinic.

Category 8: Interests

Statement of anticipated objective: To provide in the student a background for the development of interests such as further study in science, a hobby, or an avocational pursuit.

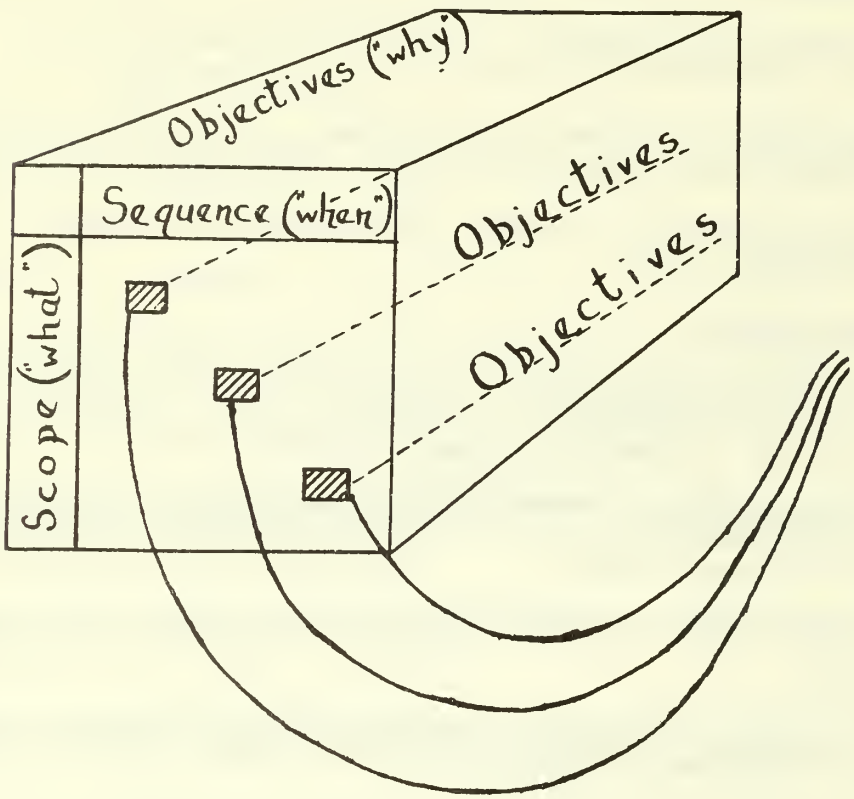
Example of a special interest: A study of light principles in a pin-hole camera.

Use of this interest: Photography as a hobby or vocational activity.

The Place of Objectives in a Three-Dimensional Program

To clarify the relationship between the objectives and the content of the course it may help to think of the total science program as being three-dimensional, the scope and sequence as the first two dimensions, and the objectives as the third. Further, we may say that the scope, sequence, and objectives are the "what", "when", and "why", respectively, of the science program. Obviously it is the third dimension that gives body to any substance, and here one might well consider that the objectives, giving purpose and direction to the entire program, is the all-important dimension. In every unit of study undertaken by the class

some attempt should be made to see that progress is made with respect to each, or most, of the specific objectives relative to the unit under study. For example, one month a class may be working on a unit on "Matter and Machines" and the next month on a unit on "Health and Safety", but in every instance there would be a genuine connection with the specific objectives. Such a relationship can be illustrated by a diagram as simple as that in Figure 1.



Certain units of study on the scope and sequence pattern each of which can, and should, tie in with the objectives of the entire program.

Figure 1. -- Diagrammatic illustration of a three-dimensional program of study.

PART THREE

THE ORGANIZATION OF THE JUNIOR HIGH SCHOOL GENERAL SCIENCE PROGRAM

The General Theme

The general theme running through the junior high school science program is the INTERRELATIONSHIP BETWEEN LIVING AND NON-LIVING THINGS IN A UNIVERSE OF ENERGY. This energy man has harnessed to a remarkable degree, but further developments still lie ahead. The energy of lifeless or inert matter knows no bounds. If the science curriculum is to receive a proper interpretation, teachers and pupils must detect this single theme running throughout the overall science program. The total environment, physical, biological and social, is therefore the stage setting for the various problem studies. Figures 2 and 3 serve to emphasize the fact that general science deals with all those environmental influences that affect man and life in general.

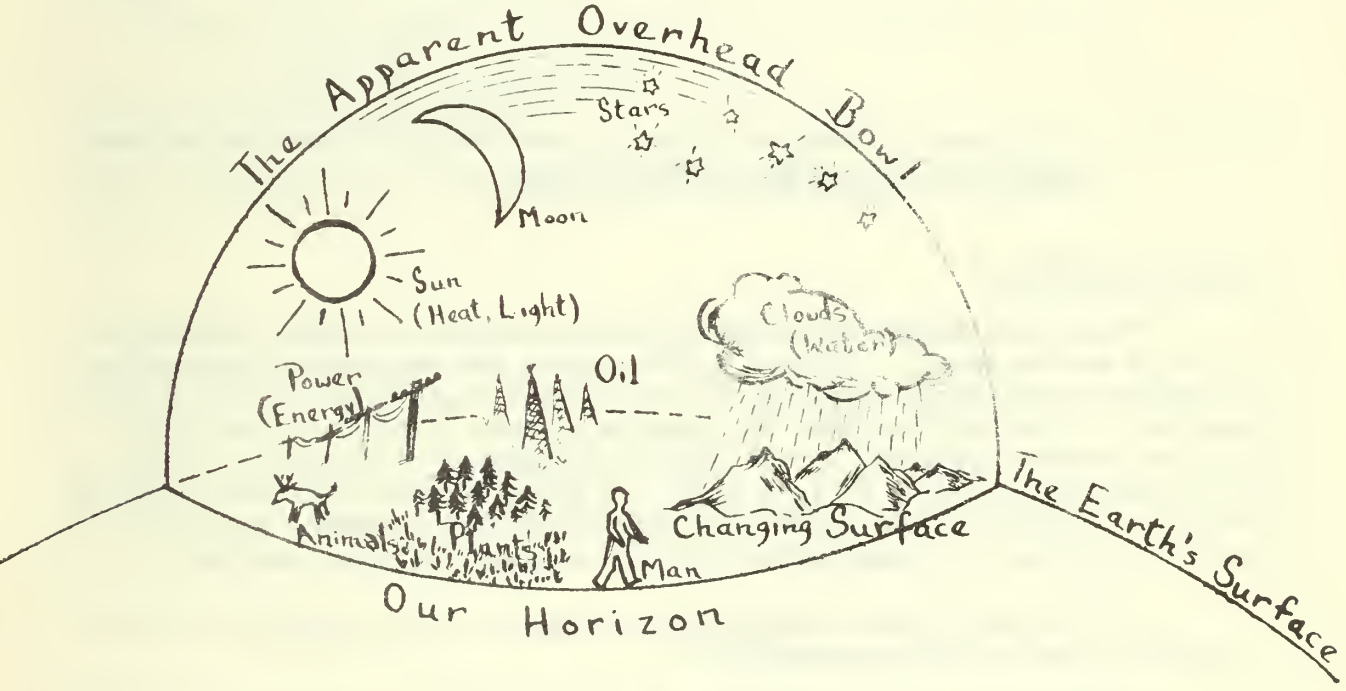


Figure 2. The Theme of Interrelationship Between Living and Non-living Things in Our Environment

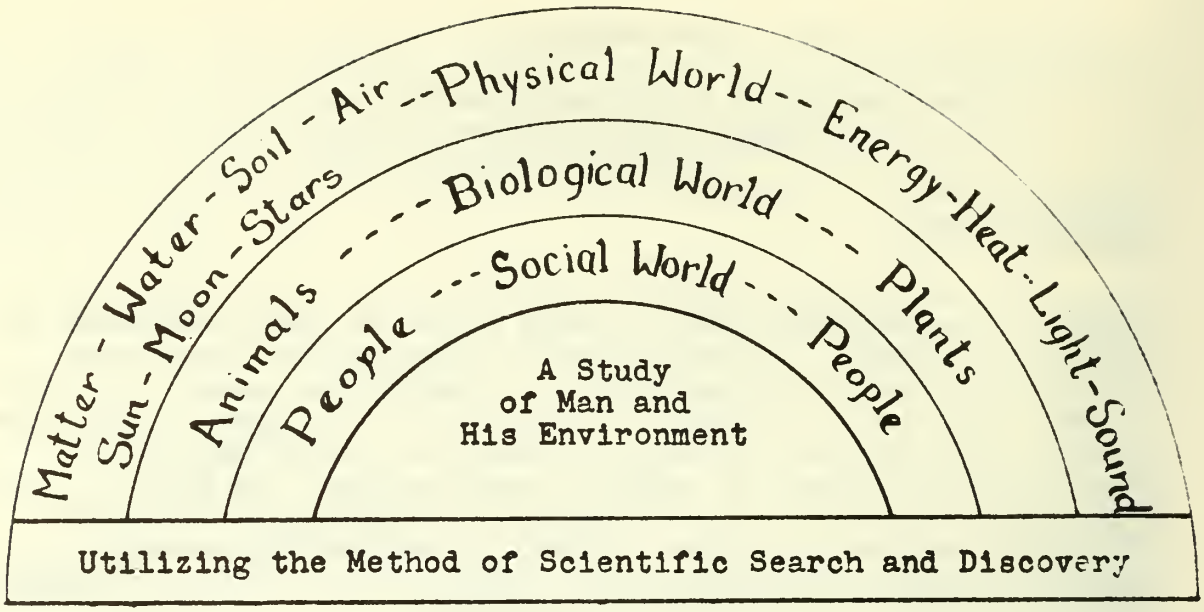


Figure 3. A Diagrammatic Representation of the Concept of Interrelationship Between Living and Non-living Things

Scope and Sequence

The modern method of arranging course content is often referred to as "scope and sequence". It is a psychological and sequential arrangement of learning experiences selected to meet program objectives as adequately as possible. It is believed that the general science curriculum should deal with the everyday problems of the learner as related to those persistent life situations of which he is a part. In place of the traditional subject-matter-set-out-to-be-learned, the science curriculum becomes a series of units or problems for study which call for at least partial solution.

The main structural organization of the science curriculum may be considered then as three-dimensional:

1. The scope, (or the "what" of the curriculum) consisting of persistent life situations;
2. The sequence, (or the "when" of the curriculum) the continuity of these situations from grade to grade and through life;
3. The objectives, (or the "why" of the curriculum) which are related to to each and every area of the scope-and-sequence program pattern.

The Scope

The scope is the content of the curriculum. It is the first dimension of the science curriculum and consists of broad areas of interest in the physical and biological world both near and far. The detailed overall pattern or framework reveals eight broad topics or areas for investigation in this dimension.

Eight Areas of Scope

1. Variety
2. Interdependence
3. Adaptation
4. The Earth in the Universe
5. The Orderly Universe
6. Change on the Earth
7. Energy and Machines
8. Health and Safety

An Analysis of the Scope Dimension

As we examine the items in the scope we note that they may be grouped into the following divisions:

A LIVING THINGS
B. HEALTH AND THE UNIVERSE
C. ENERGY AND MACHINES
D MAN'S WELL-BEING

The following table will help to clarify this analysis:

A	LIVING THINGS
	Plants, animals and humans
1	Variety. Living things display great variety.
2	Interdependence. Living things depend on each other.
3.	Adaptation. Living things are adapted to their surroundings.

B	THE EARTH AND THE UNIVERSE
	The Earth, Solar System, Stars, Space, Time
4.	The Earth in the Universe: The earth is small in proportion to the vast universe.
5.	The Orderly Universe: There is marvellous order in the universe.
6.	Change on the Earth: The earth's surface changes endlessly.

C	ENERGY AND MACHINES
	Man controls his environment
7.	Energy and Machines: Man uses energy and machines to lighten his work burden.

D	HEALTH AND SAFETY
	Man's physical well-being
8.	Health and Safety: Man uses science to investigate health problems.

Articulation with Science (and Health) of the Elementary School Grades

It is readily apparent that the scope in junior high school science articulates with, and forms an extension of, the parallel science activities of the elementary school. The first seven scope items suggested for the junior high school grades in this outline are directly related to the three scope items of the elementary science program as given in Bulletin 2, pages 98 - 103, inclusive. Scope item number 8 may be considered to articulate with the entire health program of the elementary school grades as outlined in Bulletin 2, pages 90 - 98, inclusive. This last relationship is a general one, but satisfactory since we are primarily interested in science content.

SCHOOL		ELEMENTARY	JUNIOR HIGH
Grades		I, II, III, IV, V, VI	VII, VIII, IX
SCOPE	SCIENCE	1. Living Things 2. Earth and the Universe 3. Energy and Machines	1. Variety 2. Interdependence 3. Adaptation 4. The Earth in the Universe 5. The Orderly Universe 6. Change on the Earth (chemical and physical changes) 7. Energy and Machines
	HEALTH	Health	8. Health and Safety

Figure 4. Diagram to show articulation between the elementary and junior high school science programs.

The Sequence

The Sequence is the continuity of experiences resulting from the expanding needs and interests of the pupils. This is the second dimension of the science program and consists of an enlarging sequence of unit studies from grade to grade These take on an ever-widening meaning as the learner matures and his interests and needs change. The unit studies with their related sub-topics and sub-problems furnish a continuity of ever-increasing ideas and concepts. Such concepts as The Balance of Nature, The Water Cycle, The Conservation of Resources, Keeping Fit, are repeated in different and more complex settings from year to year in order to be well understood. In brief, the sequence is the timing of the curriculum, and refers to what shall be emphasized at any particular grade level.

Time Allotment to Science Education in the Junior High School

The general science program, which includes a considerable amount of health education, is to be alloted five periods per week in each of Grades VII, VIII AND IX Such an allotment of time is a slight increase over the old program but may be considered to be justified because of (1) the increasing importance of science in modern life, (2) the need for emphasis on health and safety education, (3) the need for increased emphasis on the "language" of science, and (4) the potential contribution of science to general education.

Cycling the Sequence

In Alberta schools enrolments are often so small and the teacher load so great that a certain amount of "cycling" of the program is often necessary to meet these conditions.

For a program in general science such as this it would be preferable not to "cycle" any of the course content. However, it will be permissible where more than one junior high school grade is in one classroom, to combine the Grade VII and Grade VIII program, but the pupils in Grade IX must not be grouped with either or both of Grade VII and VIII for general science. In other words, Grades VII and VIII may be grouped and their programs cycled (sequence to be covered in two years), but Grade IX is not to be grouped with other junior high school grades.

Number of Units to be Completed Each Year

The number of units of experience to be undertaken each year will vary with individual groups of students. The course is designed on the basis of approximately a unit study per month, or six weeks, but his time-distribution is not to be considered as a rigid requirement. The amount of time spent on the study of a particular unit of learning experience, and the way in which that time is distributed among the various possible activities, will vary with individual pupils and individual groups The length of time allocated to each unit study will be determined by the particular teacher-pupil-group situation.

Flexibility Within the Program

Although the scope and sequence pattern would tend to suggest a fixed plan of unit studies, the teacher should realize that the science curriculum is flexible and permits of individual development of each child or group of children in the light of their local scene. The units that are proposed are suggestive; the sub-topics or sub-problems are not at all prescriptive.

Teachers will find that it is necessary to take into account the individual differences and varied rates of maturation of pupils and of groups of pupils. Pupil experiences will vary widely as between the rural and urban child, as between the child who lives in the prairie division, the parkland area and the northern bush region of Alberta. Children reared in a forested area around Fort Vermilion have different living experiences from those reared in the sugar beet district of Raymond and Magrath.

Some Grade IX children will be starting to think in terms of preparation for college while others will be interested in a machine-shop tradesman's qualifications. Individual interests color their contribution in a unit study and this is all to the good. However, the teacher must recognize that throughout the scope-and-sequence organization there is a common core of understandings of a general nature which are common and essential knowledge for all students. These common learnings will become a significant part of their living as citizens in a modern scientific society.

PART FOUR

THE GENERAL SCIENCE PROGRAM

The Selection of Science Content

There are three main reasons for the difficulty experienced in the selection of science content, (1) the tremendous advance in science invention and discovery in very recent years, (2) the local variations in classroom and community environment, (3) the lack of reliable research information on pupil interests at any particular grade level. Student interests of today consist of such topics as diesel buses, jet propulsion, polarized light -- topics that are far removed from learning the definitions of various types of energy, or the formula for Fehling's solution.

Selection of curriculum experiences is one of the most crucial problems in curriculum construction. Before commencing the selection it is advisable to set forth certain criteria of selection. This was done in preparing this course. Some of the most important of these criteria of selection are as follows:

1. Curriculum experiences should have valid and significant content.

2. Learning experiences should provide the opportunity for attaining a wide range of general objectives of growth.

3. Learning experiences should be appropriate to the interests and needs of the student.

4. Learning experiences must provide for continuity and sequential developments.

5. Learning experiences should have the maximum relationship to life and living.

6. Learning experiences should permit a sufficient variety of learning activities.

In the selection of the units given in the scope and sequence pattern certain criteria were kept in mind, such as: (1) the unit should be an integrated part of the total broad program related to large areas of human experience and possible of subdivision into smaller significant problems, (2) the unit should be based on direct experiences possible of extension for the more capable pupils, (3) the unit should deal with materials of interest to pupils and bear close relationship to the immediate lives of the pupils, (4) the unit should be chosen to have application to the pupil's future needs as an intelligent citizen in society, (5) in every case there should be close articulation with the preceding and succeeding units.

The Unit Studies in Junior High School Science

A detailed tabulation of unit-study organization for each of the junior high school grades consists of eight major topics (scope) with corresponding problems or unit studies to solve (sequence). These unit studies are listed in Figure 5.

An expanded outline of the proposed unit studies for junior high school with their related sub-problems follows Figure 5. These guides should serve as a ready reference for the teacher. They parallel exactly the units and sub-problems contained in the List of Unit Studies for the Junior High School Science Program (Figure 5).

Fig 5: THE LIST OF UNIT STUDIES FOR THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM

LIST OF UNITS IN THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM (Sequence)				
	SCOPE	GRADE VII UNIT STUDIES	GRADE VIII UNIT STUDIES	GRADE IX UNIT STUDIES
1.	VARIETY	7-1: How the World of Plants and Animals Constitutes an Ordered System.	8-1: How Man Has Learned to Arrange Plants and Animals into Groups According to Their Similarity.	9-1: How We Can Observe Types of Living Things All Around Us.
2.	INTERDEPENDENCE	7-2: How Plants and Animals Live Together in Nature.	8-2: How Plants, Animals and People Cooperate With Each Other.	9-2: How Living Things are Inter-dependent
3.	ADAPTATION	7-3: How Plants, Animals, and People Fit Into Their Surroundings.	8-3: How Living Things Solve Their Problems of Living.	9-3: How Plants and Animals Are Adapted to Conditions Around Them.
4.	EARTH IN UNIVERSE	7-4: How Man Explores the Universe and the Stars.	8-4: How Our Sky Contains Huge Bodies at Great Distances.	9-4: How Our "Small" Earth Takes Its Place in a Vast Universe.
5	ORDER IN UNIVERSE	7-5: How the Earth Moves in Space.	8-5: How Man Measures Time by the Movement of the Earth and of Other Heavenly Bodies.	9-5: How the Heavens Influence Us.
6.	CHANGING EARTH	7-6: How Certain Forces Are Changing the Earth's Surface.	8-6: How the Earth's Surface Has Changed and Continues to Change.	9-6: How the Earth's Surface Consists of a Continuous Series of Changing Hills and Hollows from Highest Mountain to Deepest Ocean.
7.	ENERGY AND MACHINES	7-7: How We Live in a World of Action, Movement and Machines	8-7: How Man Uses the Energy that Is All About Us	9-7: How Man Puts Energy to Work to Create a Modern World
8	HEALTH AND SAFETY	7-8: How We Safeguard Our Lives in a Modern World	8-8: How We Protect Our Health and the Health of Others	9-8: How Science Helps us to know our Bodies and How to Conserve Them.

EXPANDED OUTLINE OF UNIT STUDIES FOR JUNIOR HIGH SCHOOL SCIENCE

Each of the unit studies for Grades VII, VIII and IX is divided into sub-topics or sub-problems as follows:

GRADE VII UNIT STUDIES AND SUB-PROBLEMS

UNIT 7-1: HOW THE WORLD OF PLANTS AND ANIMALS CONSTITUTES AN ORDERED SYSTEM

Sub-problems:

7-1.1: What living things are in your neighborhood?
7-1.2: What is the work of leaves and flowers?
7-1.3: How are plants different from animals? How alike?
7-1.4: What are the forms of life found in a pond?
7-1.5: How does man attack various plant and animal pests?
7-1.6: How does the scientist classify (a) plants, (b) animals?
7-1.7: How to plan a home garden. growth conditions, planting, soil preparations, cultiviation, fertilizing, weed control, pests, preserving food products.
7-1.8: How does the scientist use the "metric system" in his work?

UNIT 7-2: HOW PLANTS AND ANIMALS LIVE TOGETHER IN NATURE.

Sub-problems:

7-2.1: How are all life forms interdependent?
7-2.2: How do living things cooperate?
7-2.3: What is meant by the "balance of life"?
7-2.4: How to study a few common insects; structure, life histories, food habits, control of pests, collections, disease carriers, economic importance.
7-2.5: What is meant by nature's "water cycle"?
7-2.6: How do all life forms depend on nature's "gifts"?
7-2.7: How does man use water in the home and community? In industry?
7-2.8: How is the "air ocean" used by all life forms? How to prepare pure oxygen?
7-2.9: What are some characteristics of air? Evidences that it presses and pushes; that it expands and contracts. Devices.
7-2.10: What is the composition of air and of what value are the air gases to us?
7-2.11: How does man use and control heat?
7-2.12: What are the sources of fuels used by man for his greater comfort?
7-2.13: What are some rules for fire prevention?

UNIT 7-3: HOW PLANTS, ANIMALS AND PEOPLE FIT INTO THEIR SURROUNDINGS

Sub-problems:

7-3.1: What are the basic needs of plant and animal life?
7-3.2: How do plants and animals obtain their food?
7-3.3; What is the general life history of plants and animals?
7-3.4: How are living things suited to life on land, in water, and in the air?
7-3.5: How are living things suited to life in different seasons?
7-3.6: How are living things suited to life in different climates?
7-3.7: How can we assist in conserving our Canadian resources; water, soil, wild life, forests, flowers, minerals, oil?

UNIT 7-4: HOW MAN EXPLORES THE UNIVERSE AND THE STARS

Sub-problems:

7-4.1: How is the sun's energy stored in the earth?
7-4.2: How do we explain the "light of day"?
7-4.3: What is the story of the stars?
7-4.4: What is the Milky Way?
7-4.5: What imaginary figures can we find in the sky?
7-4.6: How can we locate a number of main constellations?
7-4.7: How do light and colour come to the earth?
7-4.8: How do we put light to work in a camera? How to take pictures? How to develop and print pictures?
7-4.9: What do lenses and mirrors do to light?
7-4.10: What is meant by proper indoor lighting?
7-4.11: What is sound and how is it transmitted?

UNIT 7-5: HOW THE EARTH MOVES IN SPACE

Sub-problems:

7-5.1: What are the effects on man of living on a round earth?
7-5.2: What are the effects on man of living on a tilted earth?
7-5.3: What are the effects on man of living on a spinning earth?
7-5.4: What are the effects on man of living on a revolving earth?
7-5.5: Discuss the above in the light of changes in heat, sunlight, general loss and gain of energy, temperature changes in soil, air, and water, and plant and animal changes.

7-5.6: Compare the speeds of travel that man has achieved with the "natural" speed of the earth's spin and of the earth's revolution.

UNIT 7-6: HOW CERTAIN FORCES ARE CHANGING THE EARTH'S SURFACE

Sub-problems:

7-6.1: What is the story of the earth in ages past?
7-6.2: How have irregularities developed in the earth's crust?
7-6.3: What natural forces are still at work changing the earth's surface?
7-6.4: How do heating and cooling change solids, liquids and gases?
7-6.5: What types of rocks would you include in a museum collection?
7-6.6: What is the origin of the rocks in your collection?
7-6.7: What types of soil are found in your neighborhood? In Alberta?
7-6.8: How do natural factors determine weather and climate?
7-6.9: How does the Canadian Meterological Service work?

UNIT 7-7: HOW WE LIVE IN A WORLD OF ACTION, MOVEMENT AND MACHINES

Sub-problems:

7-7.1: How has man "cut down" on time and distance?
7-7.2: What simple machines does man use?
7-7.3: What are the advantages in using machines? (Changing speed, direction and amount of a force)
7-7.4: How do machines make more jobs for people? Fewer jobs?
7-7.5: What are some sources of energy?
7-7.6: How is water energy used for power, for irrigation, and for transportation?
7-7.7: How is heat energy used for power?
7-7.8: How are magnets used by man on land, sea, and in the air?
7-7.9: How is direction finding related to the earth's magnetism?
7-7.10: What are electrons?
7-7.11: How is electricity generated? How used in our homes?
7-7.12: How do switches and fuses work in simple electric circuits?
7-7.13: What are some safety considerations in handling electrical devices?
7-7.14: How does the telephone utilize electrical and magnetic principles?

UNIT 7-8: HOW WE SAFEGUARD OUR LIVES IN A MODERN SCIENTIFIC WORLD

Sub-problems:

7-8.1: What are some important rules for keeping fit? A health inventory.
7-8.2: What are some diseases we should know about?
7-8.3: Why does cleanliness pay? How should we attend to good grooming and personal appearance?
7-8.4: How do foods serve as body builders?
7-8.5: What is the importance of good posture?
7-8.6: What types of food are contained in a balanced diet?
7-8.7: What determines the amount of food we need?
7-8.8: What dangerous gases must we avoid?
7-8.9: How do we avoid accidents? First aid equipment; treatment in emergencies.
7-8.10: How do we get a supply of pure water for drinking purposes and for washing?
7-8.11: What is "healthy air"?
7-8.12: What is the value of outdoor living (health, sociability, camping, hiking; camp cooking and sanitation; hazards.)

GRADE VIII UNIT STUDIES AND SUB-PROBLEMS

UNIT 8-1: HOW MAN HAS LEARNED TO ARRANGE PLANTS AND ANIMALS INTO GROUPS ACCORDING TO THEIR SIMILARITY

Sub-problems:

8-1.1: What is meant by the "natural environment of plants"?
8-1.2: What plants are found in local plant societies?
8-1.3: What plant varieties are found in different parts of the world?
8-1.4: How are plants divided into world zone groups?
8-1.5: Review plant and animal family classifications.
8-1.6: How does man improve plants and animals by cross-breeding?
8-1.7: How are farm crops improved by careful selection?
8-1.8: Review the Metric System.

UNIT 8-2: HOW PLANTS, ANIMALS AND PEOPLE COOPERATE WITH EACH OTHER.

Sub-problems:

8-2.1: How is man dependent on plants and animals?
8-2.2: What are the interdependent phases of the process called "photosythesis"?
8-2.3: How are animals directly or indirectly dependent on green plants?
8-2.4: What is the "life-cycle" of common plants and animals? e.g., Carrot, potato, geranium; insects; fish; snake; chicken; robin; rabbit; gopher.
8-2.5: What are some plant enemies of plants?
8-2.6: How are insects both enemy and friend?
8-2.7: What is the interrelation between green plants and soil?
8-2.8: What is the value of the earth's air blanket?
8-2.9: How can air be compressed? Cause rust?
8-2.10: How do we provide for our air needs? Purity? Burning?
8-2.11: How do we provide for a water supply?
8-2.12: How do we provide for our heat needs?

UNIT 8-3: HOW LIVING THINGS SOLVE THEIR PROBLEMS OF LIVING

Sub-problems:

8-3.1: How do seasonal changes affect plants and animals?
8-3.2: How are plants and animals adapted to regional living? (hot, cold, dry, wet, temperate)
8-3.3: How are plants and animals adapted to living in fresh water? In the ocean?
8-3.4: What birds and animals migrate?
8-3.5: How do bacteria cause decay?
8-3.6: What is the balance of life and how is it upset by man?
8-3.7: How can we save our plant and animal resource?

UNIT 8-4: HOW OUR SKY CONTAINS HUGE BODIES AT GREAT DISTANCES

Sub-problems:

8-4.1: What is Astronomy? Astrology?
8-4.2: What is the story of the solar system?
8-4.3: What forces hold us and all heavenly bodies in space?
8-4.4: What conditions exist on other planets of the solar system?
8-4.5: What do you know about the moon?
8-4.6: How does the moon cause tides?
8-4.7: How are the moon phases related to the calendar?
8-4.8: Explain the light of the sun, moon, earth, a candle, electric light, photographic flash-bulbs, and trace them all to original sunlight.

UNIT 8-5: HOW MAN MEASURES TIME BY THE MOVEMENT OF THE EARTH AND OF OTHER HEAVENLY BODIES

Sub-problems:

8-5.1: How do all heavenly bodies keep on their paths?
8-5.2: What causes temperature change on the earth by day and by night?
8-5.3: How do we tell time "by the earth"?
8-5.4: How do we tell time by other heavenly bodies?
8-5.5: What are the Canadian time belts?
8-5.6: What is the story of clocks?

UNIT 8-6: HOW THE EARTH'S SURFACE HAS CHANGED AND CONTINUES TO CHANGE

Sub-problems:

8-6.1: What types of plants and animals lived in the earth's past?
8-6.2: What forces are building up and breaking down the earth's surface? Chemical, water, wind.
8-6.3: What is a seismograph and what is its use?
8-6.4: What types of rocks are found in the earth's crust? What is the rock-soil cycle?
8-6.5: How do the shape of the earth and the motion of the earth determine climate?
8-6.6: How do we explain the heat zones of the earth?
8-6.7: How is life on the earth affected by the world climate zones?
8-6.8: Why is air called the "mother of weather"?
8-6.9: What conditions effect evaporation and condensation? What are some simple cloud forms?
8-6.10: How does wind affect weather and climate?
8-6.11: How do we locate the world wind belts?
8-6.12: How do weather-measuring instruments work?
8-6.13: Experiment with some common chemical changes: iodine on starch; test for vitamin C; acids on carbonates; acid on metals; yeast on sugar; metal tarnishing.

UNIT 8-7: HOW MAN USES THE ENERGY THAT IS ALL ABOUT US

Sub-problems:

8-7.1: What are the following: work, energy, friction?
8-7.2: What are the values of bearings and lubrication in a car, sewing machine, tractor?
8-7.3: How does man utilize heat energy and radiant energy?
8-7.4: How does man use levers, pulleys and slopes to help him in his work?
8-7.5: What is the difference between temporary and permanent magnets?
8-7.6: How is magnetism related to current electricity?
8-7.7: How are conductors and insulators used in both electrical work and in heat conduction?
8-7.8: What determines the strength of an electromaguet?
8-7.9: How do the telegraph and telephone work? How do they use magnets?
8-7.10: How do electric bells and simple electric motors work? How do they use magnets?

8-7.11: How do small farm electric power systems work?
8-7.12: How is hydro-electric power generated in Alberta?
8-7.13: What is meant by high-voltage transmission?
8-7.14: How is the strength of an electric light bulb measured?
8-7.15: What is the story of air travel, including jet propulsion? (Lifting effect of an air-foil; propellor as air screw; lift, gravity, thrust, drag; plane models for experimentation; flying wings, rockets, jets.)

UNIT 8-8: HOW WE PROTECT OUR HEALTH AND THE HEALTH OF OTHERS

8-8.1: How does the body skeleton function? Bones, muscles, joints.
8-8.2: How do the various systems of the body work?
8-8.3: How do veins, arteries and capillaries work?
8-8.4: How do we keep our bodies healthy? Care of teeth, hair, skin, eyes, ears, regular examinations.
8-8.5: How do we prevent the spread of disease?
8-8.6: What should we know about patent medicines?
8-8.7: What should we know about alcohol, drugs, tobacco?
8-8.8: How do bodies build up heat or energy?
8-8.9: Why do we need much sleep and rest? Why do we need a variety of foods?
8-8.10: What types and amounts of food should we eat?
8-8.11: How does the community supervise the health of its members?
8-8.12: What does the Provincial Department of Health do in relation to Alberta's Health program?
8-8.13: What do you know abour our National Health program?
8-8.14: What sports and hobbies are conducive to good health?

GRADE IX UNIT STUDIES AND SUB-PROBLEMS

UNIT 9-1: HOW WE CAN OBSERVE TYPES OF LIVING THINGS ALL AROUND US

Sub-problems:

9-1.1: How do plants, animals and human beings differ in their distribution in mountain, plain and coastal areas today?
8-1.2: How are living things classified?
8-1.3: How has science contributed to the improvement of plants and field crops?
9-1.4: How does man domesticate animals and improve them by breeding?
9-1.5: What are micro-organisms? Yeasts, molds, bacteria?
9-1.6: Let us review the Metric System?

UNIT 9-2: HOW LIVING THINGS ARE INTERDEPENDENT

Sub-problems:

9-2.1: How do living things depend on each other?
9-2.2: What are food chains? In pond, lake, ocean?
9-2.3: What is the battle of weeds, insects, and diseases among plants and animals?
9-2.4: What plant and earth products do we use in housing?
9-2.5: How does man disturb the balance of nature?
9-2.6: What are the sources of heat, and how is it used in home and factory?
9-2.7: What are the uses of air in everyday life? Thermostat, insulation, air contaminants, air conditioning, humidity control, germicidal lamps, sun ray lamps.
9-2.8: What care may we exercise in preventing fire?
9-2.9: What are the uses of water in everyday living?
9-2.10: How is water both friend and enemy?
9-2.11: What has been the effect of water on the growth of civilization through the ages?
9-2.12: How are streams polluted? How purified?
9-2.13: How are water systems planned?
(a) gravity
(b) pump
9-2.14: How does man depend on soil for food and clothing fibres?

UNIT 9-3. HOW PLANTS AND ANIMALS ARE ADAPTED TO CONDITIONS AROUND THEM

Sub-problems:

9-3.1: How does life adapt itself to climate regions?
9-3.2: How do various types of plants reproduce?
9-3.3: How does structure determine how animals will live?
9-3.4: What food adaptation is found in roots, stems, leaves, and flowers? (osmosis, capillarity, photosynthesis, pollination, fertilization, seed dispersal)
9-3.5: How are living things protected from their enemies?
9-3.6: How does man make use of modern "substitutes"?
9-3.7: How does man convert a desert region into verdant production?
9-3.8: What large conservation projects are being undertaken in Canada and the United States?

UNIT 9-4. HOW OUR "SMALL" EARTH TAKES ITS PLACE IN A VAST UNIVERSE

Sub-problems:

9-4.1: What do we know about the sun? Size, distance, composition?
9-4.2: How may we rightly say that "the sun is the source of all the earth's energy"?
9-4.3: How is the "storage" of solar energy related to photosynthesis? How is energy transformed?
9-4.4: How are heat zones and wind belts caused by solar energy striking a ball-shaped earth?
9-4.5: How many "offspring" are there in the sun's family?
9-4.6: How do we obtain (1) light (2) colour (3) artificial sunlight?
9-4.7: Why is the moon a dead world?
9-4.8: Why are the Bay of Fundy tides so unusually high?
9-4.9: What are eclipses?
9-4.10: What is the source of solar energy? of the energy of nuclear fission? of the energy of radio-active substances?
9-4.11: What are phosphorescence and fluorescence?

UNIT 9-5: HOW THE HEAVENS INFLUENCE US

Sub-problems:

9-5.1: What seasonal "key-dates" of the year are determined by the earth's tilt, the earth's spin, and the earth's travel around the sun?

9-5.2: How is the length of a day, month and year established by the earth's spin and also its travel through space? How are the four directions likewise related to these earth movements?

9-5.3: How the system of "latitude-and-longitude" used to set up "invisible" world streets? How do we measure the altitude, latitude and longitude of your school?

9-5.4: How do we find our way with maps? And how are they a part of the earth's invisible street system?

9-5.5: How does man set up a time system? Standard time, Day-light saving time, International Date Line?

9-5.6: How are time and location on the earth really determined by the stars?

9-5.7: What is the mathematics of "light-years"?

UNIT 9-6: HOW THE EARTH'S FACE CONSISTS OF A CONTINUOUS SERIES OF CHANGING "HILLS" AND "HOLLOWS" FROM THE HIGHEST MOUNTAIN TO THE DEEPEST OCEAN

Sub-problems:

9-6.1: What does a cross-section of the Grand Canyon tell us about the earth's past? Also the dinosaur lands of the Red Deer Valley in Alberta?

9-6.2: How is solar energy the basis of all weathering and erosion?

9-6.3: What are physical change and chemical change?

9-6.4: What conditions are necessary for burning? What are the products of combustion?

9-6.5: What forces are still changing the surface of the earth?

9-6.6: What are some kinds of rocks found in the earth's crust?

9-6.7: How is soil made in nature?

9-6.8: What are some economically important mineral treasures located in the solid earth?

9-6.9: How does man use the earth's metals?

9-6.10: How does man utilize coal, gas, oil?

9-6.11: How does man utilize the "stone" of the earth?

9-6.12: How does man make concrete and other artificial rocks?

9-6.13: What are some important weather and climate principles?

9-6.14: How are weather maps prepared and interpreted?
9-6.15: What chemistry goes on in the home? cake-making, baking powder; soda-acid; bread-making; yeasts; cleaning devices; cleaning drains; action of soap; chemical changes from heat, from bacteria, from tarnishing; acid on metals; germicides and disinfectants; chlorine bleaching; protective paint coats; home cleaning cabinets; the medicine cabinet.

UNIT 9-7: HOW MAN PUTS ENERGY TO WORK TO CREATE A MODERN WORLD

Sub-problems:

9-7.1: What are the following: matter, force, gravity, work, inertia, friction, energy?
9-7.2: What are the six basic machines?
9-7.3: What are some "big" machines used in industry and on farms?
9-7.4: How is water used to develop power?
9-7.5: How is heat used to develop power? Principles of steam engine, gas engine, steam turbine?
9-7.6: What is the function of the flywheel, clutch, gears, lubrication, brake system in automobiles?
9-7.7: How is heat controlled in our homes?
9-7.8: How does light energy work in a camera?
9-7.9: How is artificial light produced?
9-7.10: What is (a) static (b) moving electricity (c) electricity by induction?
9-7.11: How do power plants produce (a) electricity at Seebe, Alberta (b) "steam-electricity"?
9-7.12: How are transformers used in an electrical distribution system (a) in cars (b) in radios (c) in high power transmission?
9-7.13: What devices use (a) direct current (b) alternating current?
9-7.14: Plan a two-way switch in the classroom.
9-7.15: How do we read an electric light meter and how is cost of power figured?
9-7.16: How is electricity used in heating and lighting?
9-7.17: How do we send messages by telegraph and radio?
9-7.18: How does a phonograph work?
9-7.19: What is the story of transportation on land?
9-7.20: What does it mean to say that "we live in an age of electronics"?
9-7.21: What are some future possibilities and some future dangers of nuclear energy?

UNIT 9-8: HOW SCIENCE HELPS US TO KNOW OUR BODIES AND HOW TO CONSERVE THEM

Sub-problems:

9-8.1: What is the story of health practices from ealiest times?
9-8.2: What are sound modern health habits?
9-8.3: What is the work of the heart, blood, and corpuscles?
9-8.4: What is the work of the body's central nervous system?
9-8.5: What are the main groups of foods called for in a balanced diet?
9-8.6: Why do our bodies need various kinds of vitamins?
9-8.7: What are some harmful and some useful bacteria? (organisms causing disease; body defense against disease.)
9-8.8: What are the statistics regarding the various causes of death in Canada?
9-8.9: How may we render first aid in case of accidents and in emergencies?
9-8.10: What are the dangers from narcotics and alcohol?
9-8.11: What are some desirable and some undesirable personality traits?
9-8.12: How do our mental attitudes affect the health of ourselves and of others?
9-8.13: What attitude should we display in facing new problems?
9-8.14: What are some public health problems? e. g., slums, pure food laws, pure milk and water, sewage disposal, garbage, etc.

PART FIVE

METHODOLOGY

Suggestions for Carrying Out the Junior High School Unit Study Activities.

1. THE UNIT STUDY

(1) The Unit-of-Work Plan

A unit of work or a unit of experience consists of a series of closely related activities needed to meet any situation faced by learners. The unit of experience is not a special type of activity applied or used in selected situations or areas of study. It is a concept which applies equally to all aspects of the curriculum. The term "unit" merely suggests a quality of Unity which arises from the definition of a problem, planning the solution, and carrying out the plans successfully and should characterize every school experience.

(2) The Scientific Method of Pursuing Unit Studies in the Junior High School.

Throughout all three grades of the junior high school, the nine unit studies are to be explored by means of the scientific method. This is the method employed by the scientist in finding out about nature, about the life of plants and animals and humans, about this earth and other heavenly bodies. This is the method employed by man in dealing with the problems of his environment. The science curriculum of the junior high school provides the student with a "research" type of "experience-learning-situation".

(3) Actual Teacher-pupil Planning of the Unit

Pupils are to share in planning the possible activities related to a particular unit. During this planning teacher guidance is all-important. It is the teacher's responsiblity to consider a balance of activities for a particular day or over a longer period of time, in relation to the maturational level of the pupils and in the light of their previous experiences. The teacher must bring to the pupils supplementary instructional materials in the form of books, audio-visual aids, community resource material and equipment for experiments and for construction work. It must be recognized that all details of planning cannot be set up in advance. As teachers and students carry out their progressive planning and as new needs arise, suggestions from individual pupils and from the teacher will call for revision of earlier planned activities.

(4) Starting the Unit

Planning with students at the start of every unit calls for an over-view discussion. At this time the likely sub-problems are also discussed. The teacher should welcome pupil suggestions, but in turn will find it necessary to delimit the overview.

After ways of solving the problems have been discussed, the matter of source material, references and of committee and individual responsibility, are agreed upon. Work begins. From time to time small groups, or the whole class, come together for progress-stock-taking or for progress-reports, and also for next-step-discussions. It is in such sessions that revision of earlier plans takes place.

(5) Daily Planning

In order to timetable the day's activities, short day-by-day planning periods, under teacher's guidance, are necessary. The time assigned to day-by-day planning depends on the progress stage of the unit. The amount of teacher responsibility for suggestions will depend on the maturity of the learners.

(6) Unit Versus Topical Organization

Modern curriculum trends frown on science organized on the topical plan which results in stress on fact learning and emphasis on detail. Unit studies should contribute to the enrichment of life as the main aim of science teaching.

(7) The Textbook and Unit-study Procedure

The textbooks selected for junior high school science have been chosen because they are set up on the unit plan. Teachers should experience no difficulty in gathering material for the unit studies proposed in this science curriculum. Each unit of the three-year program has been thought out in terms of scope and sequence principles and all deal with important phases of the student's environment. Each unit should contribute to the broad educational objectives given in Part Two.

(8) The Textbook Plan in a Modern Junior High School Curriculum

The junior high school science curriculum is planned for the investigation of a series of unit studies. Three 3-book series and one 2-book series have been recommended for basic research study, supplemented by a secondary list of references. The teacher and/or superintendent should select a basic science series, one book of which the student may purchase each year.

(9) Library

Superintendents and principals should see that the school library is sufficiently well equipped with a selection of the books listed under special and seondary references for each grade. If the problem-solving method with its concomitant outcomes is to succeed, then reading and research materials must be readily available for the solution of the problems to be undertaken.

The building and organization of a serviceable library is an important aspect of the teacher's work. It can only render maximum service to students if carefully administered. Students must, therefore, be trained to use the library properly and to assist in its operation.

2. CLASSROOM ACTIVITIES

(1) General Science Equipment and the Science Classroom

Special equipment for the teaching of general science is as essential as for the teaching of art and dramatics. The following factors should receive consideration for the adequate handling of general science at the junior high school level:

(a) A science demonstration and experiment desk
(b) Adequate cupboard and storage space
(c) Sufficient work space
(d) A water supply, and, if possible, gas and electricity
(e) Equipment for handling a wide range of activities (see list of recommended materials and equipment, pages 48-52.)

(2) A Science Corner for Experimentation

This is a worth-while project in any classroom, but especially in rural schools and in those town schools lacking a special science laboratory.

(3) Setting up a School Museum

A well-arranged museum, containing materials made by students and brought from home, will motivate the learner in many of the units, for example: Variety of Life, Change in the Earth's Crust, and so on.

(4) Experiments and Demonstrations

Both teacher-demonstration and pupil-demonstration of experiments are essential parts of a good science program and both methods of experimentation are of value. It is likely that in order to save time and money, teacher demonstration, rather than individual performance of experiments may be resorted to on occasion.

(5) Home-made Equipment

There is a considerable amount of learning and understanding which results from the manufacture and improvising of home-made equipment. Such items as: a pneumatic trough, retort stands, wire mesh, alcohol lamps, water pressure system for the science corner, graduates, balance, test tube stands, test-tube holders, test-tube racks, coefficient of expansion apparatus, may all be improvised by the student under an imaginative teacher.

(6) Reports and Summaries

Training in clear organization and presentation of ideas is an art that teachers should guide and develop in children. Such ability cannot be expected to be an automatic concomitant of the unit studies. Since a great deal of the student's interest is centered around modern invention and discovery, periodic discussion of current events in science should form an important part of classroom activities.

(7) A Student Notebook

The student notebook should reflect his own interest and endeavor and should never contain mass dictation of notes by the teacher. The notebook, preferably loose leaf, should contain important summaries of student reports, teacher's summaries of significant information, clippings from periodicals and newspapers, records of experiments, answers to thought questions, simple labelled diagrams, short-answer test items.

Long involved science "stories" of performed experiments are too time-consuming and are not justified from the standpoint of writing by the student or correction by the teacher.

Elaborate, exact, and artistic drawing of apparatus set-ups and biological specimens is not justified in terms of resultant values to the student. Inking or coloring of "lab" drawings is not considered psychologically sound practice. The practice of having children copy elaborate and detailed drawings from textbooks is to be condemned.

(8) Scrapbooks

This is the type of activity that appeals to certain students, but not to all. The scrapbook should not become a book of scraps. This is an excellent opportunity for the transfer of habits learned in the Art class to carry over into the student's science notebook and the class scrapbook.

(9) Workbooks

Workbooks require careful interpretation and direction. Teachers are referred to workbooks and guide books which supplement certain of the 3-text series. They contain valuable suggestions to teachers and students.

Student workbooks, if used at all, must be selected with care. The type of workbook that consists entirely of short answers such as single words, short phrases, completing or labelling diagrams, or filling in short-answer observations and conclusions is of doubtful value.

A well-designed workbook should contain guidance instructions to the student in order that he may carry out experimental work, research study, and other activities in and out of school.

(10) The Science Club

Such an organization may well take over the arrangements and planning for visits to field and factory, communications with provincial authorities on the formation of calf and swine clubs, and even the direction of a chess-and-checker club.

(11) Bulletin Boards

The school or classroom bulletin board should contain a section labelled SCIENCE, for current clippings from newspapers and periodicals.

(12) Organizing a Field-trip

An excursion into nature's laboratories or to industrial plants should be carefully planned beforehand. Directed observations and "post-trip-reports" will guarantee appropriate understandings.

3. AUDIO-VISUAL AIDS

Films and Film-strips

Teachers should procure from the Department of Education and from the University Department of Extension catalogs from which a selection of science film-strips may be made. Films serve a variety of purposes. They may be used to orient, to clarify, to supplement, and must always be suited to the maturation level of the children. A preliminary discussion before the filming, followed by a discussion after viewing the film is strongly recommended. It is hoped that divisional libraries will in time contain a film bureau in order to gain the greatest benefit from the use of films as an aid to science teaching.

4. DIRECTING THE UNIT STUDIES

(1) A General Pattern for Unit Study
(The scientific method of problem-solving)

Introductory Items:

(a) Title of the Unit
(b) Statement of the Problem

I: The Setting of the Unit

(a) The Physical Environment
(b) The Type of Community
(c) The Type of School
(d) The Pupils' Home Backgrounds
(e) The School Grade
(f) The Time Required for the Unit

II. The Objectives of the Unit

(a) General Objectives
(b) Specific Objectives

III: Outline of the Content of the Unit

IV: Methods and Materials

(a) Method
(b) References

V: Developing the Unit

(a) Initiatory Activities
(b) Developmental Activities

(c) Culminating Activities
1. Closing off the unit
2. Critical evaluation

VI: Correlations

.....

Definitions:

1. A unit of work: A series of teacher-guided pupil activities to achieve a dominant purpose held by the pupils.
2. Attitudes: Ways of thinking and feeling.
3. Appreciations: Sympathetic evaluations.
4. Understandings: General concepts resulting from organizing and interpreting the meanings of the various aspects of a situation.

(2) (A sample unit)

Note: The first unit of Grade VII is now outlined in detail in order to guide the teacher in the handling and direction of the unit study method.

Title of Unit 7-1:

HOW THE WORLD OF PLANTS AND ANIMALS CONSTITUTES AN ORDERED SYSTEM

The problem: How does the scientist arrange the world of plants and animals into a systematic classification?

I: The setting for the unit -- (Factors to be considered)

A. The environment: Prairie, Parkland, Mountain, or Bushland of Alberta.

B. The community: Well established; new Canadians; cosmopolitanism, rural or urban.

C. Home background of pupils: Radios, reading materials, rural or urban, etc.

D. Grade level: seventh.

E. Time for the unit study: four to six weeks.

The purpose of this unit is to give the child an orderly acquaintance with living and non-living things that make up his environment. A study of the major plant and animal groups will introduce the child to the scientist's method of organizing knowledge. Students should have some understanding of the methods employed in preparing a systematic arrangement of all life forms.

This unit will assist boys and girls in their subsequent unit studies on adaptation and interdependence of living things.

II. The objectives of the unit -- It is a help to the teacher to list the outcomes or general concepts before starting the unit. It will give her a clear picture of the actual learning outcomes of the unit and will assist in focusing on the objectives. It will also aid in the preparation of test and evaluation materials in checking pupils' comprehension of important ideas.

A. General objectives

Note: It is better to have pupils arrive at their own understandings or generalizations. Pupils should be encouraged to state what they themselves have discovered to be the understandings they have acquired in the course of studying the unit. It may be necessary however to assist them in this discovery.

1. FUNCTIONAL CONCEPTS

The following basic understandings should be developed by the pupils during the study of the unit.

(a) Living things vary greatly.
(b) All things in the world may be grouped into two main kinds:
    (1) living things
    (2) non-living things
(c) Some living things are simple and some are very complex.
(d) Living things produce large numbers of eggs or seeds.
(e) Only small numbers of potential offspring survive.
(f) Flowers are the reproductive parts of plants.
(g) Some life forms are beneficial and some harmful.
(h) Animals and plants differ in shape and structure.
(i) Pupils should possess an understanding of the way that structure determines classification of living things.
(j) Pupils should develop an understanding that things that are alike in certain ways are put into groups.

A MAIN CONCEPT

SIMILARITIES AND DIFFERENCES BOTH IN PLANTS AND ANIMALS PERMIT A SCHEME OF CLASSIFICATION INTO GROUPS THAT ARE ALL ALIKE IN STRUCTURE WITHIN THE GROUP.

2. INTERESTS

(a) Making collections of specimens and illustrations of living and non-living things.
(b) Color photography.

3. PROBLEM-SOLVING SKILLS

(a) Utilizing the scientific method of problem-solving in the unit study.
(b) Sensing and defining a problem; studying the problem situation; making suggested hypotheses; selecting and testing the suggested proposals; accepting and rejecting tested suggestions; drawing conclusions.
(c) Applying conclusions to new situations.

4. ATTITUDES

The basic understandings, sensed as the unit progresses, will result in a development of attitudes. The following attitudes may be expected:

(a) A scientific attitude of study and research.
(b) Cooperating with others in the solution of problems.
(c) An attitude of individual and of group responsibility.
(d) All people should share in the available supply of living and non-living things.

5. FUNCTIONAL INFORMATION AND KNOWLEDGE

(a) A wide knowledge of life forms which may be of direct use to the average citizen.
(b) A wide knowledge of non-living things which are of direct value to the average citizen.

6. APPRECIATIONS

(a) Problems of food, clothing, and shelter are related to living things on the earth.
(b) The more that can be learned about life forms on the earth, the better will we understand our problem of conservation of plant and animal resource.
(c) The more that can be learned about the valuable non-living materials, the better will we understand our problem of conservation of coal, gas, and mineral resource.
(d) Pupils should develop an awareness that man's comfort depends on the ready availability of living and non-living things.
(e) Pupils should develop the appreciation that the scientist does not generalize without a lot of evidence.

7. INSTRUMENTAL SKILLS

(a) To read science content with comprehension in order to gather pertinent information required to solve the problem or unit.
(b) To make charts and diagrams to help solve the unit study.
(c) To manipulate science equipment in experiments.

B. Specific Objectives

1. To know --

(a) The main groups of vertebrate (back-boned) animals.
(b) The main groups of invertebrate (non-back-boned) animals.
(c) The main groups of seed plants that have flowers.
(d) The main groups of seed plants that have no flowers.
(e) The main groups of plants that have no seeds.
(f) The names of the parts of a flower.

2. To discover --

(a) The similarities and differences in groups of plants.
(b) The similarities and differences in groups of animals.

3. To learn --

(a) The simple vocabulary of plant and animal groups.

4. To observe --

(a) To observe accurately and to record the facts of an experiment.

III. Outline of the content of the unit --

A. The two main groups of living things, and their value to man.

B. How living things resemble each other.

C. How non-living things resemble each other.

D. How we can tell what group an animal belongs to.

E. How we can tell what group a plant belongs to.

F. The classification of the total plant world.

G. The classification of the total animal world.

H. Observation and collection of living and non-living things.

I. Simple experiments suited to the topic.

J. Care of plants and animals in school and out.

"No one knows how many individual plants make up the plant world. In a square mile of jungle there are plants by the million. In a single acre of wheat there are many thousands of wheat plants alone. Even a drop of water may contain hundreds of very tiny plants.....among all these plants some are very much alike. Others are very different. By studying their likenesses and differences, scientists are able to classify them." (Plant World, Basic Science Education Series.)

Algae, bacteria, fungi, lichens, mosses, horsetails, ferns, seed plants, flowering plants, are some kinds of plant life forms.

Some common family names of flowering plants that grow in Alberta are: rose family, pea family, cross family, composite family, heath family, willow family, mustard family; the scientist uses more complicated names than these that are listed.

"Animals are sometimes defined as living things that have the power of locomotion. It is true that most animals can move from place to place while most plants cannot. But some animals stay in one place all their lives, while some plants are able to move through water easily." (Animal World, Basic Science Education Series).

"Some scientists list very small living things as animals; some list them as plants. Others, by calling them "plant-animals", suggest that they belong on the border-line between the two kingdoms." (Animal World, Basic Science Education Series).

There are in the whole world billions and billions and more billions of individual animals.

Students should understand the meaning of the word species. About a million species of animals are known.

The words family, order, and classes should be distinctly understood. Lynxes and panthers belong to the cat family. The cat family belongs to the order of carnivores or flesh eaters; The carnivores belong to the class of mammals.

About 95 per cent of all the species of animals in the world are invertebrates.

Protozoa, sponges, jelly-fish, coral, sea cucumbers, worms, mollusks, crustaceans, myraipods (many-feet), spiders, insects, fishes, amphibians, reptiles, birds, and mammals, are some kinds of animal life forms.

IV. Method and materials --

The method of search study and report by individuals, groups, and committees will be employed in the solution of the unit problem. Numerous types of activities, suited to individual capacities and interests, will be used. The study lends itself well to museum and collection work, and to the preparation of significant charts and diagrams.

These various activities should lead to understandings, appreciations, and functional knowledge.

References:

A. Primary:

1. EXPLORING OUR WORLD: Powers, Ginn and Company, 1946, Unit 5.

2. EXPLORING SCIENCE: Smith and Traftson, Longmans, Green and Company, 1946, Unit 2.

3. GOING FORWARD WITH SCIENCE: Craig and Lewis. Ginn and Company, 1947, pp. 4 to 62, and pp. 290 to 310. (This reference rates fair).

4. DISCOVERING OUR WORLD, Book I, Teacher's Edition: Beauchamp. W. J. Gage and Company, Unit 1 (This reference is very helpful).

5. UNDERSTANDING OUR ENVIRONMENT: Carroll. The John C. Winston Company Ltd. Unit 2.

6. THE PLANT WORLD, ANIMAL WORLD, LIVING THINGS, three booklets, Basic Science Education Series. The Copp Clark Company. (These references are extremely suitable.)

B. Secondary:

1. SCIENCE PROBLEMS, Book 1: Beauchamp. W. J. Gage and Company, 1946. Unit 8.
2. UNDERSTANDING SCIENCE: Watkins and Perry. The Macmillan Company of Canada, 1940. Unit 10.
3. MODERN SCIENCE IN OUR ENVIRONMENT: Dull, Henry Holt and Company, 1942. Units 1 and 2.
4. ANIMALS WE KNOW, ANIMALS OF THE SEASHORE, BIRDS, DOMESTICATED ANIMALS, FISHES, INSECTS AND THEIR WAYS, INSECT FRIENDS AND ENEMIES, REPTILES, SPIDERS, -- DOMESTICATED PLANTS, DEPENDENT PLANTS, LEAVES, TREES, sixteen booklets, Basic Science Education Series, The Copp Clark Company.

V. Developing the Unit --

A. Initiatory Activities --- These activities serve to introduce the unit and are for the purpose of orienting the students to the study in the following ways:

1. Motivating the student by arousing his interest in the study.
2. Providing a reasonably common background for the group;
3. Raising questions and issues for exploration.
4. Defining areas or limitations for study.
5. Laying out a plan for action.

(a) As an initial activity the teacher may show a film like "The Living World" (16 mm. silent, No. Q-239, from the Audio-Visual Aids Branch, Department of Education).

or (b) Pupils should read one or two accounts of the variety of living and non-living things in the world. (e.g. "Living Things", Basic Science Education Series).

or (c) A pre-test may be given to diagnose student needs on the subject.

or (d) A field trip to observe plant and animal life may be conducted.

or (e) A newspaper account of local drought which has affected our food supply may be discussed.

or (f) Crop varieties and garden products may be taken up.

or (g) A summer trip to a zoo may be organized. (Note: A sound film, No. T-185, entitled "Animals of the Zoo", is procurable from the Department of Education.)

or (h) An arranged bulletin board with pictures may serve to orient the students.

B. Developmental activities -- Students will work in small groups, and as individuals, with a view to sharing information.

1. Planning in terms of problem-solving: Following the preparation furnished by the initiatory acitivities, the class will have background to plan with the teacher the types of activities and

procedures that will result in attaining the objectives of the unit. Questions or problems may be raised (defining the problem) by teacher pupils, which will lead to basic understandings. Pupils may make suggestions (propose hypotheses) or express opinions which will be confirmed or disproved in class. If pupils fail to see problems or make proposals, the teacher should guide their thinking and doing. The teacher may have to suggest activities additional to those proposed by the pupils.

2. Planning in terms of outcomes: The teacher should think of the seven functional outcomes listed earlier in this unit. In planning the unit teachers must realize at all times that the activity is a means to an end and not an end in itself.

3. Suggested developmental activities

The following developmental activities are suggested for teacher and pupil investigation. They are by no means prescriptive, nor must all be completed. The list will give teachers an idea of the types of activity in which students may engage according to their ability and interest.

(1) Plan a class excursion to discover what living things are found in the community neighborhood. (Pupils are to be instructed what to watch for during the trip; a follow-up discussion takes place after trip is completed.)
(2) Reading and study by a committee to prepare a report on: "How Plants are like Animals and How They are Different."
(3) An investigation to find out the forms of life in a near-by pond.
(4) Prepare a summary outline to tell: "How All Non-living Things Are Alike."
(5) Write to the Provincial Department of Agriculture for information on ways to attack plant and animal pests of your community.
(6) A report by a committee on the work of leaves of a plant.
(7) A report by a student to the class, using a large colored chart, on the function or use of the flower in the life of a plant. Make a "strip" diagram of a flower to show how the attractive outer portions of the flower may be removed to discover the reproduction parts underneath. Label the parts of the flower clearly with printed labels and arrows.
(8) Mount a set of vials containing the grain seeds of your district. Collect the seeds when you are out on a fall hike.
(9) Make a collection of mounted weed plants common in your locality, indicating briefly the method of eradication for each plant. Perhaps someone in the district could give a talk on the subject of "Weeds and Their Control".
(10) Examine flowers of the garden pea, sweet pea, clover, alfalfa, carragana, buffalo bean; make drawings of each; if you decided to classify them, how would you make your decisions? Why? What is a suitable common name for the family which you would like to suggest? What name does the scientist give to the family?
(11) Bring two very different plants to school; have two students tell the class about the structure or build of the plants; one should tell how they are alike; the other tells how they are different.
(12) Experiment with plants to discover the ideal conditions for germination of seeds.

(13) Have a committee report on how penicillin is made; is penicillin a plant of an animal?

(14) Try to find out about Burbank, Mendel, and Linnaeus. Make a booklet of the life and work of these plant scientists.

(15) Bring a puffball to school. Let it dry out, then press it and watch the cloud of spores that come from it. How would you classify this plant?

(16) An experiment: Fill a small bottle or test tube half-full of grape juice, raspberry juice, or apple juice. Put a piece of yeast cake in it. Watch to see what changes take place from day to day and record the changes.

(17) Try to make a plaster picture of a leaf.

(18) Try to make a calsomine spray of a leaf or a set of leaves, (a) on paper, (b) on cloth. Use a fly-tox sprayer to get the effect. Perhaps you would like to frame the finished spray picture for your home bedroom.

(19) Make a collection of different kinds of pressed flowers.

(20) Plan a trip to the Calgary or Edmonton zoo. What would you look for? If you can't get to a zoo, make a picture zoo. Separate the pictures into groups and mount them in a class scrapbook.

(21) Procure pictures of several types of birds. Mount them in the scrapbook and show in summary form the ways in which birds differ from other animals.

(22) Make a wall chart to show how the submarine is like a fish. Show also how they are different. Use drawings.

(23) Read to discover how to prepare information for a large summary chart in four sections to show (1) how reptiles are alike, (2) how all insects are alike, (3) how amphibians are alike, (4) how mammals are alike.

(24) Try to procure a bat and mount it as a typical mammal; if possible mount it in skeleton condition and compare its body structure with your own.

(25) Catch a spider and put it in a terrarium. It may spin a web there and may even lay eggs. Observe carefully.

(26) An animal riddle: Choose an animal. Describe its structure. Do not tell the class which animal you have selected. Try to describe its build so carefully that they can guess what animal it is.

(27) Which of the following are mammals? Armadillo, skunk, cocker spaniel, cow, snake, beaver, hen, crow, platypus. How do you know?

(28) Make several collections of non-living things for the museum. (Types of wood, of rock, of soil, and buttons).
What characteristics are common to all of them?

(29) Have your teacher help you to make a chart of PLANTS OF THE WORLD, and ANIMALS OF THE WORLD. Use simple words to classify the families on the chart. Do not put down words you do not understand. Refer to the two booklets: THE PLANT WORLD, and ANIMAL WORLD, in the Basic Science Education Series. Have a class discussion of the chart to see if they are satisfied with it and understand it. This is a valuable assignment for an interested committee.

(30) Make note-summaries of the following:
(a) Characteristics of non-living things.
(b) Characteristics of living things.
(c) Characteristics of five different plant families.
(d) Characteristics of six major animal groups.

(31) As a group project, prepare an illustrated booklet in two parts: (i) ANIMALS, (ii) PLANTS. Subdivide the first part of the booklet into: Section A: Animals with backbones and Section B: Animals without backbones. Procure pictures of the following main families of vertebrates (backboners):

(a) Mammals
(b) Birds
(c) Reptiles
(d) Amphibians
(e) Fish

Procure pictures of the following main families of invertebrates (spineless):

(a) Insects
(b) Spiders
(c) Many-footers (centipedes)
(d) Crustaceans (crabs, lobsters)
(e) Mollusks (snails, clams, oysters)
(f) Worms
(g) Starfishes (echinoderms)
(h) Jelly-fishes (coelenterates)
(i) Sponges
(j) Protozoa (paramoecium, amoeba)

Subdivide the second part of the book into:

Section A: Plants with seeds

(a) Flower or fruit seeds
(b) No flower seeds (cones)

Section B: Plants without seeds

(a) Ferns
(b) Mosses
(c) Algae
(d) Fungi

(32) Write a short essay of three paragraphs telling: "What the Scientist Does When He Puts Things in Groups".

C. Culminating Activities

1. A display:

Prepare a corner of the classroom for a display of what you have learned in this unit. Make two large signs:

(a) LIVING THINGS
(b) NON-LIVING THINGS

Then make two more signs:

(a) ANIMALS
(b) PLANTS

Then make six smaller signs:

(a) Birds
(b) Fish
(c) Mammals
(d) Reptiles
(e) Amphibians
(f) Insects

Then make two signs:

(a) Plants with flowers and seeds
(b) Plants with no flowers and no seeds

Try to obtain actual specimens, or failing this, procure illustrations or make sketches for each of the headings. Make an attractive arrangement and invite parents or the Home and School Association to see it.

2. Critical evaluation

(a) Self-appraisal

i. Each pupil shall prepare a careful sentence outline of the unit.
ii. Each pupil shall prepare a list of statements illustrating their reaction to phases of the unit.
iii. Each pupil shall write out three understandings or generalizations and expand them into a short paragraph; have these read in class; and have a class discussion on the readings.

(b) Group evaluation (ref. Ogburn)

In order to determine the progress made by the pupils, students should be tested for (1) information, (2) understandings, (3) attitudes, (4) other intangible outcomes.

(1) Information test: The objective test of the true-false, best answer, and completion types are suitable. The essay type may also be used. For example:
Draw a circle around T if the statement is true
and a circle around F if the statement is false.

T F The pistil is on the outer part of a flower.
T F Mendel was responsible for the scientific classification of plants.
T F The dog is both mammal and carnivore.

(2) Understanding test. The multiple-choice or best-answer types are very suitable for measuring understandings. In setting up test answers include one basic understanding, one opposite statement, a partly correct generalization, and a controversial or debatable generalization. The pupil will identify the correct answer, the incorrect answer, the partly correct answer, and the debatable statement. For example:

Place the letter R before each answer that is right, W before each answer that is wrong, D before the statement that is debatable, and P before each statement that is partly true.

Plants and animals are valuable to man because

....They should be completely consumed without replacement
....They lighten his work burden
....They furnish him with food material
....They provide coming generations with oil

(3) Attitude test. If you agree with the statement and hold the same attitude, place the letter A on the dotted line in front of it; if you do not have the attitude expressed, place the

letter D before it; if you cannot make up your mind whether the attitude expresses your point of view or not, place a question mark in front of it.

.....Timber removal from our forests should not be an indiscriminate affair.
.....The government should take over the control of all our natural resources and guarantee that all people share in the returns of them.
.....All Canadians should study the information on production and distribution of our plant and animal products.
.....Private enterprise is unfair because it robs people of the necessities of life obtained from plants and animals.
.....The scientist shows us how to organize knowledge.

(4) Testing intangibles

(a) Study habits and methods of work. State in a few sentences what you would do in each of the following situations:

i. You are assigned a study problem which requires examining a number of books of reference in order to discover material that deals with the subject. You are in a classroom that has ten basic texts, five supplementary references and a small encyclopedia.

ii. You cannot find a definite answer to a problem-question because three books you have read are in disagreement regarding the subjects in question.

iii. You find that you are distracted by the slightest noise in the classroom when you are studying and you cannot keep your mind on the problem you are investigating.

(5) In closing off the unit, the teacher may procure a film (e.g. a 16 mm. silent: "How Life Begins", Nos. Q-42, Q-43, Q-44, Q-45, procurable from the Audio-Visual Aids Branch of the Department of Education). A class discussion should follow the showing.

(6) In finally evaluating the unit the teacher should ask herself:

i. Does the unit meet the objectives set out under Section II at the start of this unit?

ii. Does the unit meet the sixteen criteria of a good unit, listed in Section V, under the heading "Developmental Activities?"

VI. Correlations

A. Reading
B. Spelling
C. Writing
D. Art
E. Language (speech)
F. Social Studies

PART SIX

APPARATUS, EQUIPMENT AND MATERIALS

FOR THE JUNIOR HIGH SCHOOL SCIENCE COURSE

The following list is divided into three sections. Section A contains the minimum essential requirements for the course. These items should be in every school in which the science course if offered. Section B contains items that may readily be purchased locally or may easily be improvised. Many of these items can be obtained at very little cost. Section C contains the more expensive items of equipment. This equipment makes an important contribution to the science course and should be purchased as funds permit.

The quantities shown on the right of the list are suitable for the use of small groups of students in the smaller type of school. In larger schools or in schools where individual experimentation and demonstration is practised larger supplies may be necessary.

SECTION A

DESCRIPTION	QUANTITY
ACID: Muriatic. Label and mark "POISON"	12 ounces
AMMETER-VOLTMETER	1
AMMONIUM HYDROXIDE	1 pound
AQUARIUM, about 6" x 8" x 14"	1
BAKING SODA	1 pound
BALLOONS: Toy	1 dozen
BEAKERS: Pyrex, 500 cc.	4
BEAKERS: Pyrex, 400 cc.	½ dozen
BEAKERS: Pyrex, 250 cc.	½ dozen
BEAKERS: Pyrex, 100 cc.	½ dozen
CANDLES	½ dozen
CAPILLARY TUBES	1 set
CLAMPS, retort, 6"	1/3 dozen
CLAMPS, rubber tubing	2
COMPASS	1
COPPER SULPHATE	½ pound
CORK, BORER	1
CORKS, assorted	1 package
CRUCIBLES. 60 mm.	2
CRUCIBLE TONGS	1 pair
DEFLAGRATING SPOON	1
DOORBELL, electric	1
DRY CELLS	½ dozen
EPSOM SALTS	½ pound
ERLENMEYER FLASKS: Pyrex, 250 cc.	½ dozen
EVAPORATING DISHES, 60 mm.	2

DESCRIPTION	
FEHLING'S SOLUTION #1	
FEHLING'S SOLUTION #2	
FILTER PAPER, 6"	1 package

FLASHLIGHT BULBS AND SOCKETS	$\frac{1}{4}$ dozen
FLORENCE FLASKS, flat bottom, pyrex, 50 cc.	$\frac{1}{2}$ dozen
FORCEPS, 5"	1 pair
FORMALDEHYDE	1 pound
FUNNELS: Glass, 60 mm.	2
FUR, cat's	
GLOBE, earth	1
GRADUATES: Cylindrical, 50 cc.	1
GRADUATES: Cylindrical, 100 cc.	2
IODINE	1 small bottle
IRON FILINGS	$\frac{1}{2}$ pound
LAMPS: Alcohol, or Bunsen Burner	2
LAMP CHIMNEYS	4
LEAD, for wet cell, 5" x 1" x $\frac{1}{4}$"	2 bars
LODESTONE	1
LIMEWATER TABLETS	1 package
LITMUS PAPER: Blue	1 vial
LITMUS PAPER: Red	1 vial
MAGNESIUM RIBBON	2 ounces
MAGNET: Permanent, horseshoe	1
MAGNET: Permanent, bar	2
MANGANESE DIOXIDE	$\frac{1}{2}$ pound
MARBLE CHIPS	
MEDICINE DROPPERS	2
MERCURY	4 pounds
METER STICK	1
MICROSCOPIC SLIDE GLASSES	12
MOTOR: Troy	1
PARAFFIN	1 pound
PITH BALLS	
POTASSIUM CHLORATE	$\frac{1}{2}$ pound
POTASSIUM PERMANGANATE	$\frac{1}{4}$ pound
PRISM: Glass	1
PULLEY: Double, bakelite, approx. 2"	2
PULLEY: Single, bakelite, approx. 2"	2
PUMP: Combined pressure and vacuum	1
PUMP: Force, glass model	1
RETORT STANDS, with 4 rings, 5"	2
ROD: Ebonite	1
ROD: Glass	1
SCALE: Simple spring, graduated in ounces	1
SILK	
SIMPLE CELL	1
STOPPERS: Rubber, assorted, solid and holed	
SULPHUR FLOWERS	$\frac{1}{2}$ pound
SULPHURIC ACID	1 pound
TABLE SALT	1 pound
TEST TUBE BRUSHES	3
TEST TUBE HOLDERS	3
TEST TUBES: Pyrex, 30 cc.	1 dozen
TEST TUBES: Pyrex, 4" x $\frac{1}{2}$"	1 dozen
THERMOMETERS: Centigrade, Fahrenheit	1/3 dozen

THERMOMETER: Indoor	1
THISTLE FUNNELS	¼ dozen
TORCELLIAN TUBE	1
TOUCH PAPER	1 package
TUBING: Glass, assorted	2 pounds
TUBING: Rubber, ¼" inside	10 feet
TUNING FORK	1
VINEGAR	1 pint
WATCH GLASSES	2
WATER SOFTENER	1 package
WHEEL AND AXLE STAND	1
WICKS, for alcohol lamps	½ dozen
WING TOP, for Bunsen Burner	1
WIRE: Copper, #22, on spool, not insulated	2 pounds
WIRE: Double cotton covered, #24	½ pound
WIRE: Gauze squares, asbestos centered, 5"	2
WIRE: Magnet, enamelled, #24	½ pound
WIRE: Picture, braided	1 package
WOOD ALCOHOL	1 quart
"Y" CONNECTOR TUBES: Glass	¼ dozen
ZINC CLIPPINGS	½ pound

SECTION B

ANT'S NEST	
BATTERY JAR, Large, 1 gal.	1
BATTERY JAR, Small	1
BICYCLE PUMP, old	1
BLUEING	1 package
BOARD, approx. 1" x 10" x 4"	1
BOTTLES, assorted, wide mouth	4
BOW DRILL	1
CAMERA: Box, old	1
CAMERA: Pinhole, old	1
CARDBOARD	
CARBON RODS from old dry cells	
CART, for inclined plance	1
"C" CLAMPS, 5"	2
COLLECTIONS OF: rocks, fossils, cocoons, soils, shells, plants, insects, etc.	
COLLECTIONS OF: skulls, jawbones, teeth, etc. of various animals	
CONVECTION CURRENT APPARATUS	1
CUPBOARD, Science	1
DESK, Experimentation	1
DISTILLATION APPARATUS	1
DRIED FRUITS, e. g., raisins, prunes, etc.	
DRILL with bits	1
DRY CELLS, old	
ELECTRIC IRONS, old	
ELECTRIC LIGHT BULBS, old	
ELECTRIC LIGHT SOCKET	1
ELECTRIC SWITCHES	
ELECTRO-MAGNET	1

ELECTROPLATING APPARATUS, Complete	1
ENGINE BLOCK, with pistons, valves, crankshaft, etc.	1
FILE, Triangular	1
FLASHLIGHT	1
FLORENCE FLASK: Pyrex, flat bottom, 1000 cc.	1
FLOWER POTS, Assorted sizes	6
FUSES: Old	
FUSES: Tin foil	
GLASS PLATES, 4" square	6
GLUE	
HACKSAW	1
HAMMER	1
HYGROMETER	1
IRON "U", for electro-magnet	1
KNITTING NEEDLES, steel	2
LAMPS: Gasoline, coal oil, etc., old	
MAGNIFIER	
NICHROME ELEMENT, from electric iron	
PHONOGRAPH AND RECORD, old	
PLIERS	
PNEUMATIC TROUGH	
RADIO TUBES, old	
RAIN GAUGE	1
SAND: Coarse	½ pound
SAND: Fine	½ pound
SAW	
SEEDS: Beans	¼ pound
SEEDS: Corn	¼ pound
SEEDS: Nasturtium	¼ pound
SEEDS: Peas	¼ pound
SCREW DRIVER	1
SIMPLE ELECTRIC MOTOR	1
SPARK PLUGS	
SQUARE, Carpenter's	1
STARCH	1/4 pound
STORAGE BATTERIES	
SUGAR	1 pound
SWITCHES, Electric	2
TEA KETTLE	1
TELEGRAPH KEY AND SOUNDER	1
TELEPHONE RECEIVER AND TRANSMITTER	1
TELESCOPE, Simple	1
TEST TUBE RACK	1
THERMOS BOTTLES, old	
TIN PLATE FOR RETORT	1
TUMBLERS OR JAM JARS	½ dozen
VIVARIUM	1
WEDGES	
WIND GAUGES	
WINDLASS, Working model	1

SECTION C

BALL AND RING SET	1
BAROMETER: Aneroid	1
BEAKER TONGS, 8"	1 pair
BELL JAR AND BASE	1
BLOCK AND TACKLE	1
COMPASS	1
COMPOUND BAR	1
CONDUCTOMETER	1
GENERATOR: Magneto, hand-operated	1
INSECT PINS, Assorted	100
KILLING BOTTLES, insect	
MICROSCOPE: Compound	1
MORTAR AND PESTLE	1
RADIOMETER	1
RIKER MOUNTS, 5" x 7"	1 dozen
SPECIMEN JARS	1 dozen
STEAM ENGINE, toy or cross-section model	1
THERMOMETER: Maximum-minimum	1
TRANSFORMER	1

PART SEVEN

TEXTBOOKS AND REFERENCES FOR THE SCIENCE COURSE IN THE JUNIOR HIGH SCHOOL

The Department of Education has authorized the use of four series of science books. These are listed as primary references. All of them give an adequate coverage of the course. The teacher, in consultation with the superintendent will select from this list a basic textbook for use in the classroom. Each student will be expected to purchase or will be provided with a copy of the basic text thus selected. To assist the teacher and superintendent in making a choice, brief reviews of each series are given below.

No single book will meet all the requirements of the year's work in science. It is intended that pupils shall use the recommended primary textbook as a guide to and a general reference for the work involved in each unit of the course. More detailed information on certain sections of the course will be required for reports and classroom discussion than is to be found in the basic reference. The selection or rejection of information on the grounds of pertinence to the unit in hand is a technique of fundamental importance, requiring an adequate library of science books. This library of reference books may be built up from the books listed as secondary references.

It is recommended that students have general access to at least three of the 3-book series suggested as references. The texts have been selected in such a way that various factors or themes of the environment are repeated from year to year. Thus concepts such as "order in nature", or the "omnipresence of change" are developed through concrete experiences in each of the three texts.

Guide to Selection of Primary References

(a) THE SCIENCE IN MODERN LIFE SERIES: Smith and Trafton

A three-book series for Grades VII, VIII and IX and a composite book for Grade IX.

The content of this series is functional. Up-to-date information on transportation, housing, communication and other important activities have been included.

The series has been selected on three points:

i Inclusion of subject matter in each of the three texts according to difficulty.

ii Vocabulary has been carefully checked according to the findings of Curtis, based upon Teachers' Word List by Thorndike.

iii A natural sequence of scientific thought has been worked out based upon complexity of relationships.

The organization of the series follows the psychological unit method. A review of each unit is provided by exercises designed to give the child opportunity to relate his knowledge to major principles. Additional study aids are included such as: daily test exercises, questions and directions for observations of suggested demonstrations, word lists and definitions, lists of appropriate visual aids, and suggested follow-up activities.

The sequential arrangement of units from one text to the next in the series provides for experiences with increasingly difficult concepts. The amount of material in each of the texts in the series is sufficient for one year of work.

(b) OUR WORLD OF SCIENCE SERIES: Craig and Lewis

A two-book series for Grades VII and VIII, which is an extension of OUR WORLD OF SCIENCE SERIES for Grades I - VI inclusive.

The books of this series are quite attractive in design. The coverage of subject matter is broad, and the use of narrative style may provide ease of learning. Attractive illustrations contribute to the usefulness of this series.

At the end of each section of subject matter appear two features: (i) "More Things To Think About", and (ii) "Some Things To Do." Lists and definitions of science words appear at the end of each text.

This series is well designed to bring about the establishment of basic concepts in the student's mind.

(c) ADVENTURING IN SCIENCE SERIES: Powers, Neuner, Bruner and Bradley

A three-book series for Grades VII, VIII and IX and a composite book for Grade IX.

This series utilizes the unit plan of organization. The books are designed to offer in a three year period repeated contacts with each of the areas of subject matter included. The texts are adequately illustrated.

There are interesting introductions to each chapter, and exercises are frequently introduced. At the end of each chapter there are aids of the following types: "Correct These Statements", "Questions for Discussion" and "Things To Do". Each text includes a list of Readings in Science, and a list of defined science terms.

(d) INTERPRETING SCIENCE SERIES: Carroll.

A three-text series for Grades VII, VIII and IX.

The topics included in this series seem more limited in breadth of scope than in some of the other series. Topics dealt with in one text are not necessarily studied at an advanced level in the next book of the series. The books are attractive in design and are adequately illustrated.

The unit approach to organization has been used. There is a decided emphasis upon experiments evident in the exercises included in these texts. Other types of study aids include "Things To Do", and "Things To Think About", the type of exercise varying from chapter and appearing in such form as "Questions To Think About".

Guide to Special References

(a) THE MODERN WONDER BOOK OF KNOWLEDGE: (Winston Company, 1949)

This is a special reference book and is not a text. It should be found in every school library. The book contains a great deal of very valuable information for the science student in junior high school grades, and is very reasonably priced.

There are 690 pages of up-to-date material on scientific progress in the twentieth century dealing with industry, science, nature, transportation, communication, and marvels of the age of science. It is well written, beautifully illustrated, and the vocabulary is well within the range of Grade VII, VIII and IX pupils.

(b) THE LYNDE SERIES: three books.

These three books are included in this special list because of their emphasis on performing experiments with home or inexpensive equipment. They are written in an interesting and effective manner and should be in every school library. They are not texts for student purchase.

Grade VII Texts

PRIMARY REFERENCES

1. EXPLORING SCIENCE: Smith and Trafton (Longmans, Green & Co.) 1946, (THE SCIENCE IN MODERN LIFE SERIES: Book 1 for Grade VII)
2. GOING FORWARD WITH SCIENCE: Craig and Lewis (Ginn & Co.) 1946 (OUR WORLD OF SCIENCE SERIES: Book 1 for Grade VII)
3. EXPLORING OUR WORLD: (New edition): Powers, Neuner, Bruner and Bradley (Ginn & Co.) 1946. (ADVENTURING IN SCIENCE SERIES: Book 1 for Grade VII)
4. UNDERSTANDING OUR ENVIRONMENT: Carroll (Winston Co.) 1947. (INTERPRETING SCIENCE SERIES: Book 1 for Grade VII)

SPECIAL REFERENCES

1. THE MODERN WONDER BOOK OF KNOWLEDGE: (Winston Co.) 1949, 690 pages. This is a special reference book for the school library. It is not a textbook, but will serve as initial reading to motivate research on many of the topics of the junior high school course.
2. SCIENCE EXPERIMENTS WITH HOME EQUIPMENT: Lynde (International Textbook Company) 1936, 226 pages). (A library book for laboratory use).
3. SCIENCE EXPERIMENTS WITH INEXPENSIVE EQUIPMENT: Lynde (International Textbook Company) 226 pages. A library book for laboratory use).
4. SCIENCE EXPERIMENTS WITH 10-CENT STORE EQUIPMENT: Lynde (International Textbook Company) 1939, 226 pages. (A library book for laboratory use).

SECONDARY LIST

1. OUR ENVIRONMENT--ITS RELATION TO US: Carpenter & Wood; (Allyn and Bacon Company) 1942. (ADVENTURES IN SCIENCE SERIES: Book 1 for Grade VII).
2. SCIENCE PROBLEMS FOR THE JUNIOR HIGH SCHOOL: Beauchamp (Gage & Company) 1946. (Book 1 for Grade VII.)
3. MODERN SCIENCE IN OUR ENVIRONMENT: Dull (Holt & Co.) 1942. (Book 1 for grade VII)
4. UNDERSTANDING SCIENCE: Watkins and Perry (Macmillan Company) 1945. (SCIENCE IN OUR MODERN WORLD SERIES: Book 1 for Grade VII)

Grade VIII Texts

PRIMARY REFERENCES

1. ENJOYING SCIENCE: Smith and Trafton (Longmans, Green & Co.) 1946. (THE SCIENCE IN MODERN LIFE SERIES: Book 2 for Grade VIII)

2. SCIENCE PLANS FOR TOMORROW: Craig and Lewis (Ginn & Co.) 1947. (OUR WORLD OF SCIENCE SERIES: Book 2 for Grade VIII)
3. OUR WORLD CHANGES (New edition): Powers (Ginn & Co.) 1946. (ADVENTURING IN SCIENCE SERIES: Book 2 for Grade VIII)
4. UNDERSTANDING OUR WORLD: Carroll (Winston Company) 1947. (INTERPRETING SCIENCE SERIES: Book 2 for Grade VIII)

SPECIAL REFERENCES

1 THE MODERN WONDER BOOK OF KNOWLEDGE: (Winston Co.) 1949.
2, 3, 4, THE LYNDE SERIES: (See nos. 2, 3, 4 under Special References for Grade VII).

SECONDARY REFERENCES

1. OUR ENVIRONMENT--HOW WE ADAPT OURSELVES TO IT: Carpenter and Wood (Allyn and Bacon Co.) 1943. (ADVENTURES IN SCIENCE SERIES: Book 2 for Grade VIII).
2. SCIENCE PROBLEMS FOR THE JUNIOR HIGH SCHOOL: Beauchamp (Gage and Co.) 1946. (Book 2 for Grade VIII)
3. MODERN SCIENCE IN OUR DAILY LIFE: Dull (Holt and Co.) 1942. (Book 2 for Grade VIII)
4. UNDERSTANDING SCIENCE, Book 2: Watkins and Perry (Macmillan Co.) 1945. (SCIENCE IN OUR MODERN WORLD SERIES: Book 2 for Grade VIII)

Grade IX Texts

PRIMARY REFERENCES

1. USING SCIENCE: Smith and Trafton (Longmans, Green & Co.) 1946. (The Science in Modern Life Series: Book 3 for Grade IX)
2. USING OUR WORLD (New edition): Powers (Ginn & Co.) 1946. (ADVENTURES IN SCIENCE SERIES: Book 3 for Grade IX)
3. UNDERSTANDING THE UNIVERSE: Carroll (Winston Co.) 1947. (INTERPRETING SCIENCE SERIES: Book 3 for Grade IX)

SPECIAL REFERENCES

1 THE MODERN WONDER BOOK OF KNOWLEDGE: The John C. Winston Co. Ltd., 1949. (This book is indispensable for Grade IX science studies.)
2, 3, 4. THE LYNDE SERIES: (See Nos. 2, 3, 4 under special references list for Grade VII.)

SECONDARY REFERENCES

1. OUR ENVIRONMENT--HOW WE USE AND CONTROL IT: Carpenter and Wood. Allyn and Bacon (ADVENTURES IN SCIENCE SERIES: Book 3 for Grade IX)

2. SCIENCE PROBLEMS FOR THE JUNIOR HIGH SCHOOL: Beauchamp. W. J. Gage and Company, 1946. (Book 3 for Grade IX)
3. MODERN SCIENCE: Dull. Henry Holt and Company, 1942. (Book 3 for Grade IX)
4. UNDERSTANDING SCIENCE, Book 3: Watkins and Perry. The Macmillan Company of Canada, 1945. (SCIENCE IN OUR MODERN WORLD SERIES: Book 3 for Grade IX)
5. SCIENCE--A STORY OF PROGRESS AND DISCOVERY: Davis and Sharpe. Henry Holt and Company, 1936. (This is a single text and not part of a series.)

ILLUSTRATED UNIT BOOKS IN SCIENCE: School Aids and Textbook Publishing Company, Toronto.

Each of these eight unit books is liberally illustrated with photographs by several of Canada's leading outdoor photographers. A wealth of factual material is included in each one.

ANIMALS OF WOODS AND PLAINS
BIRDS OF PREY
BUTTERFLIES AND MOTHS
SWIMMING AND DIVING BIRDS
TREES
THE RODENT FAMILY
WINTER BIRDS
SKY STUDIES

THE BASIC SCIENCE EDUCATION SERIES: The Copp Clark Company.

These small booklets are very attractively illustrated and well suited to the spiralled pattern of the junior high school course. The titles indicate that they follow unit studies of the scope-and-sequence curriculum. Since teachers will be seeking science material under the scope headings of the over-all chart, these basic science books have been arranged according to the eight headings of the scope. The booklets are recommended as worthwhile primary reference material for the science library for Grade VII, VIII and IX students.

I. VARIETY OF LIVING THINGS AROUND US:

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Animals of the Seashore
2. Animals We Know
3. Animal World
4. Birds
5. Fishes
6. Insects and Their Ways
7. Insects, Friends and Enemies
8. Plant World
10. Reptiles
11. Six-legged Neighbors
12. Spiders
13. Toads and Frogs

II INTERDEPENDENCE AMONG LIVING THINGS AROUND US

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Canada's Coastal Fisheries
2. Dependent Plants
3. Fire
4. Fire, Friend and Foe
5. Man's Use of Plants and Animals
6. Our Ocean of Air
7. Plant and Animal Partnership
8. The Air About Us
9. The Garden and Its Friends
10. Trees
11. Water
12. Water Supply

III. ADAPTATION AMONG LIVING THINGS AROUND US

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Adaptation to Environment
2. Animal Travels
3. Balance in Nature
4. Domesticated Plants
5. Domesticated Animals
6. Flowers, Fruits, and Seeds
7. Garden Indoors
8. Insect Societies
9. Leaves
10. Plant Factories
11. Saving Our Wild Life
12. Seeds and Seed Travels
13. Tall Timber
14. The Story of Pulp and Paper in Canada
15. Thermometers: Heat and Cold

IV THE EARTH AND THE UNIVERSE

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. The Sun and Its Family
2. Light
3. Sound
4. The Sky Above Us

V AN ORDERLY UNIVERSE

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Beyond the Solar System
2. The Earth's Nearest Neighbor
3. The Sun and Its Family

VI CHANGE IN OUR ENVIRONMENT BOTH NEAR AND FAR

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. America's Oil
2. Animals of Yesterday
3. Ask the Weather Man

4. Buried Sunlight
5. Clouds, Rain, and Snow
6. Heat
7. Life Through the Ages
8. Stories Read from Rocks
9. Soil
10. The Earth's Changing Surface
11. The Story of Oil in Canada
12. The Ways of the Weather
13. The Earth a Great Storehouse

VII. MATTER, ENERGY AND MACHINES

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Canoe to Air-liner
2. Electricity
3. Gravity
4. Machines
5. Magnets
6. On the Airways
7. The Science of Building
8. Toys
9. What Things Are Made Of
10. Wonderful Wings

VIII. HEALTH AND SAFETY OF PEOPLE AROUND US

Titles in the BASIC SCIENCE EDUCATION SERIES:

1. Community Health
2. Daily Bread and Other Foods
3. Foods
4. How We Are Built
5. Keeping Well
6. Public Health in America
7. The Fight Against Germs
8. You As a Machine

Teachers' References

1. A PROGRAM FOR TEACHING SCIENCE: National Society for the Study of Education. Thirty-first Yearbook, Part I. Public School Publishing Company, Bloomington, Ill., 1932.

2. DEVELOPING A CURRICULUM FOR MODERN LIVING: Stratemeyer. Bureau of Publications, New York. Teachers College, Columbia University, 1947. (Contains a good treatment of curriculum issues and a sound explanation of scope and sequence.)

3. MODERN METHODS AND MATERIALS FOR TEACHING SCIENCE: Heiss. The Macmillan Company of Canada, 1940.

4. SCIENCE EDUCATION IN AMERICAN SCHOOLS: National Society for the Study of Education, Forty-sixth Yearbook, Part I. Public School Publishing Company, Bloomington, Ill., 1947.

5. SCIENCE FOR THE ELEMENTARY SCHOOL TEACHER: Craig. Ginn and Company, Toronto, 1940. (Although written primarily for elementary teachers, this is an excellent exposition of the philosophy of science teaching and serves as splendid back ground even for the junior high school teacher.)

6. SCIENCE IN GENERAL EDUCATION: Report of the Committee on the Function of Science in General Education: Commission on Secondary School Curriculum. D. Appleton Century Company, New York, 1938.

7. SCIENCE IN THE ELEMENTARY SCHOOL, INCLUDING AN ACTIVITY PROGRAM: Croxton. McGraw-Hill Book Company, New York, 1937. (Good reading material for junior high school teachers also.)

8. TEACHING ELEMENTARY SCIENCE, SUGGESTIONS FOR CLASSROOM TEACHERS: Blough and Blackwood. American Council on Education, Washington, D. C., Bulletin No. 4, 1948.

9. THE MEASUREMENT OF UNDERSTANDING: National Society for the Study of Education. Forty-fifth Yearbook, Part I. Public School Publishing Company, Bloomington, Ill., 1946.

10. THE TEACHING OF SCIENCE IN ELEMENTARY AND SECONDARY SCHOOLS: Noll. Longmans, Green & Company, Toronto, 1939.

Further References for Teachers

1. HUMAN DESTINY: Du Nouy. Longmans Green and Company, Toronto. (A modern physicist's attempt to reconcile science and an idealistic philosophy of life. He postulates a telic universe and opposes a materialistic theory of the universe.)

2. MAN -- AN AUTOBIOGRAPHY: Stewart, George R. Random House, New York, 1946.

PART EIGHT

EVALUATION

Evaluation versus Testing

Examinations and tests have been long considered as the means of measuring the results of student learning. Such instruments were the direct result of a simple psychology which stressed mental discipline and mastery of facts. Today there is a demand for a newer type of evaluation instrument which will measure all outcomes of science instruction. There is a need to develop a kind of evaluation technique which will measure the extent to which those science objectives which function in the total child's behavior are being achieved.

Evaluation Defined

Evaluation is a relatively new technical term, introduced to designate a more comprehensive concept of measurement than is implied in tests and examinations. It involves the identification and formulation of the objectives of a course, their definition in terms of pupil behavior, and the construction of valid, reliable, and practical instruments for appraising the specified phases of pupil behavior. The instruments of appraisal might include achievement and attitude tests, questionnaires, interviews, controlled observation techniques, anecdotal records, stenographic reports, and sound recordings.

Modern Evaluation in Science

Evaluation procedures in general science must recognize the total growth and behavior of the child and not merely his ability to memorize specific factual information. To do this it will be necessary for us to take each of our objectives and rewrite them in terms of desired behavior before deciding what our evaluation techniques should be. For example, under factual generalizations we may have one of our objectives as the use of factual generalizations for the purpose of making predictions in new problems. The behavior pattern desired here would be the frequent use of factual generalizations to predict. This growth may be discovered by means of a paper-and-pencil test, but, on the other hand, daily observation and anecdotal records may play a part in such evaluation. Then again, suppose we have the development of the scientific attitude as one of our objectives. We should decide what behaviors would indicate growth in the scientific attitude and develop evaluation instruments to measure growth.

Teachers will find that the business of doing a complete job in evaluation will help them in making their instruction more effective. That is to say, if a teacher has definite objectives outlined and desired behavior patterns indicated, his instruction will naturally be more meaningful and purposeful.

Teachers should realize that the paper-and-pencil test has definite limitations and cannot be depended upon as a sound instrument of evaluation for the measurement of total growth. For example, growth in attitudes and certain skills cannot be fully measured without the use of observational techniques and anecdotal records. However, as the paper-and-pencil test

will continue to be the most popular instrument of appraisal for some time to come, we should attempt to improve written tests so that more objectives are evaluated and better learning and instruction are encouraged.

A life-centered curriculum is based on general education or general understandings, and science experiences must contribute to skills, habits, appreciations, attitudes, abilities, as they function in life. There is need for a great deal of experimentation in those phases of evaluation techniques and procedures which will measure the degree of achievement of these life functions. The outcomes of science instruction have now been clearly defined. It is necessary, however, to think of each outcome in terms of actual and specific pupil behavior. Certain outcomes can be evaluated quite easily, others are more difficult to appraise. We must refine our evaluation instruments to measure the degree to which all eight science outcomes are measured in relation to the total behavior of the child. The section on Evaluation, pp. 46 - 47, Part Five, gives some definite suggestions with respect to the evaluation of some of the life functions mentioned in this paragraph.

Problem-Situation Tests

There is need for experimentation with the new problem situation tests. These are especially well-suited to the field of general science and measure such factors as: the ability to formulate hypotheses, to evaluate data, to check judgment against evidence, application of principles, the nature of proof. The test consists of a problem situation with given information to aid in its solution. After a description of the problem is read by the student, he is called on to decide a sound course of action.

CURRICULUM GUIDE